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Financial instruments for mitigation, adaptation and energy poverty actions

Covenant of Mayors Guidebook | Complementary document 5

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Contact information
Name: Giulia MELICA
Address: European Commission, Joint Research Centre, Via Enrico Fermi 2749, 21027 Ispra (VA), Italy
Email: Giulia.MELICA@ec.europa.eu
Tel.: +39 0332 78 9842

EU Science Hub
https://joint-research-centre.ec.europa.eu

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Todeschi, V., Bertoldi, P., Hernandez Moral, G., Clementi, E., Treville, A., Melica, G.

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CONTENTS

Abstract

The Covenant of Mayors for Climate and Energy (CoM) is an ambitious initiative for local climate and energy actions. This document complements the main CoM Guidebook by setting out a targeted framework for municipalities to identify financial barriers and opportunities while exploring a variety of traditional, innovative, and alternative financing instruments to support the implementation of mitigation, adaptation and energy poverty actions outlined in sustainable energy and climate action plans.

While being in a position to drive the transition to low-carbon and resilient cities, municipalities face significant challenges, including limited budgets, insufficient administrative capacity, and technical and regulatory obstacles. To overcome these barriers, it is essential to integrate traditional funding sources and financing instruments such as grants and soft loans into the funding mix, while also making use of innovative models like public-private partnerships, green bonds, green loans, and citizen-based mechanisms, including cooperatives and crowdfunding.

The document explores several key financial instruments, emphasising the role of grants in financing initial investments, soft loans for enabling large-scale projects, and leasing for acquiring energy-efficient equipment without substantial upfront costs. Among the innovative instruments available, it highlights the value of green bonds, green loans and insurance mechanisms for climate adaptation. Alternative approaches, such as crowdfunding and energy cooperatives and communities, are also effective in fostering community engagement and expanding the financial base for local initiatives.

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This document builds on the previous Guidebook 'How to develop a Sustainable Energy and Climate Action Plan (SECAP)' published in 2018, in particular on the work done on Part 3C by Palermo Valentina, Andreanidou Konstantina, Zancanella Paolo.

1 Introduction

The transition towards sustainable and low-carbon urban systems demands significant financial investment and poses various challenges for municipalities. The complexity of climate finance instruments –including their institutional, technical and regulatory aspects– often slows progress. Addressing these barriers requires a comprehensive understanding of available financing sources, innovative financial tools, and strategies to overcome institutional obstacles.

This complementary document aims to provide municipalities with a comprehensive and easy-to-navigate guide on financing instruments that can support sustainable energy and climate action plans (SECAPs). The introduction outlines the role of municipalities and the key challenges, and provides an overview of financing instruments. The following sections delve into specific categories of instruments: Section 2 presents traditional instruments (e.g. grants, soft loans, and tax incentives), Section 3 focuses on innovative instruments (e.g. green bonds, energy performance contracts, carbon pricing), and Section 4 delves into alternative instruments (e.g. crowdfunding, energy cooperatives). Each section explores the characteristics, benefits, and challenges of these instruments, supported by case studies and practical examples. Section 5 concludes by providing recommendations to overcome financing barriers and enhance the effectiveness of climate-financing strategies. Finally, a financial mechanisms matrix, in the annex, provides further details for municipalities.

1.1 The role of municipalities in funding and financing

To ensure the success of SECAPs, in addition to determining the climate and energy actions to be carried out, it is essential to explicitly quantify their financial implications. This includes estimating the overall investment needs, identifying available funding sources, and mapping out a provisional financing strategy. A well-developed financial section within the SECAP enhances the credibility of the plan, facilitates access to funding, and supports the prioritisation measures. It also enables municipalities to anticipate funding gaps and proactively explore a suitable mix of financing instruments.

Municipalities are central in bridging the gap between financial planning and implementation, ensuring that the investment strategies set out in SECAPs are translated into effective and coherent climate actions. Their responsibilities include identifying funding sources, fostering partnerships, and ensuring efficient allocation of resources to maximise climate and social benefits. Despite their strategic position, municipalities face institutional, regulatory, and technical challenges that necessitate innovative approaches to finance mitigation, adaptation, and energy poverty actions.

Municipalities can identify sources of funding and financing, and utilise both for their SECAPs. Funding is typically grant-based, provided by governments and NGOs, and focuses on public benefits without requiring financial returns. Financing, however, involves investments with an expected return, and often targets economically viable projects. Both are essential for cities to effectively implement climate resilience initiatives. Examples of **EU funds** are the European Structural and Investment Funds (ESIF) –including the Cohesion Fund, the European Regional Development Fund (ERDF), the European Social Fund Plus (ESF+) and the Just Transition Fund (JTF)–, the Social Climate Fund (SCF), the Modernisation Fund, the European Agricultural Fund for Rural Development, the European Territorial Cooperation/Interreg, direct management funds such as LIFE, Horizon Europe, the Recovery and Resilience Facility, and other indirect management funds, such as the European Urban Initiative, the InvestEU, the Public Sector Loan Facility for a just transition, and financing from the European Investment Bank (EIB).

Additionally, municipalities have the capacity to design and implement a diverse range of additional financial instruments (Commission for the Environment - Climate Change - Energy 2024). These include tax-based tools, such as green levies, or tax increment financing schemes, which can generate additional revenue and influence private investment decisions in line with sustainability goals.

Moreover, municipalities are increasingly engaging with private actors, including renewable-energy suppliers and service providers, through public-private partnerships and third party investment models. Their deep understanding of the local context allows them to structure these collaborations effectively, ensuring shared risks and benefits, and fostering trust among individuals, private investors, and technical professionals. This integrated approach enhances the scalability and impact of financial schemes supporting mitigation, adaptation, and energy poverty actions.

1.1.1 Financing mitigation actions

Mitigation actions, aimed at **reducing greenhouse gas** (GHG) emissions, often require significant upfront investments in renewable energy, energy efficiency (EE), and sustainable transport infrastructure. These investments are usually funded through public financing but may also involve private financing mechanisms, such as public-private partnerships or green bonds. To address these challenges, municipalities make use of a combination of public and private financing instruments.

- **Public funding**: national and regional governments may provide grants and subsidies to support renewable-energy projects, energy-efficient retrofits, and public transport initiatives. These instruments are the most widely used financing mechanisms and often cover not only direct project costs but also associated services such as technical assistance and energy audits. EU funds, such as the Cohesion Fund and ERDF, also play a vital role in funding large-scale mitigation projects. Increasingly, municipalities combine funding streams from national and EU sources to amplify their impact.
- **Public-private partnerships (PPPs)**: PPPs enable the sharing of financial risks and technical expertise. For instance, municipalities collaborate with private investors to develop solar energy parks or upgrade public lighting systems with energy-efficient LEDs under energy performance contracts. These partnerships are particularly effective in leveraging private capital for public benefit.
- **Green bonds**: cities increasingly issue green bonds to attract private capital for climate-related projects. These bonds involve institutional investors as well as private individuals seeking environmentally beneficial investment opportunities. An example is the city of Gothenburg [1], Sweden, which has used green bonds to finance sustainable transport systems and energy-efficient infrastructure.
- **Community-based models**: energy cooperatives and crowdfunding platforms empower citizens to invest directly in local renewable-energy projects, fostering ownership and engagement. For example, community-funded solar farms or district heating networks provide opportunities for collective action on mitigation.

[1] https://mycovenant.eumayors.eu/docs/benchmarks/docs/114420_1415957090.pdf

To support these mechanisms, complementary instruments such as revolving funds, carbon pricing and energy service companies can enhance the effectiveness of financing strategies (Economidou et al. 2021, 2023).

1.1.2 Financing adaptation actions

Challenges faced by climate adaptation projects differ from those faced by mitigation actions, mainly because such projects often lack the clear financial returns that attract traditional investors. Adaptation projects -such as improving water infrastructure or building coastal defences- primarily deliver social and environmental benefits, which do not always translate into immediate or direct financial gains. As a result, financing for adaptation is harder to secure. Unlike mitigation projects, which often have bankable models with clear returns on investment, adaptation efforts struggle to attract private capital due to their complex, long-term nature.

However, despite these challenges, financing is necessary for adaptation. It enables the scaling up of critical infrastructure and resilience initiatives that are essential for communities to withstand and adapt to climate impacts. Innovative financial mechanisms and public-private partnerships can help bridge the gap, making financing a vital addition to grant-based funding to address the multifaceted needs of climate adaptation. Both are crucial to ensure comprehensive and effective climate resilience.

Financing adaptation actions remains a significant challenge for municipalities, and the current level of funding is largely inadequate and falls short of what is required (Cities Climate Finance Leadership and Alliance 2024). The Adaptation Gap report finds that progress in adaptation financing is not sufficiently fast to close the enormous gap between needs and flows, and that this contributes to a continued lag in adaptation planning and implementation efforts. The disparity between the funding and resources currently available for adaptation, and what is actually needed for an effective response to climate impacts, poses a significant challenge -especially as climate events become more frequent and severe.

For **vulnerable groups**, such as low-income communities, the adaptation gap is particularly burdensome. These communities often face the greatest risks from climate change impacts but have limited capacity to cope with them. They may struggle to afford infrastructure improvements, insurance premiums and other necessary measures, leaving them disproportionately exposed to climate risks. This financial strain exacerbates existing inequalities and highlights the urgent need for targeted funding and innovative financing solutions to bridge the adaptation gap.

Additionally, many urban adaptation plans rely on short-term external funding tailored to specific goals, such as risk assessments, but these funds often expire before achieving broader objectives (AEA 2013). To boost financing for adaptation actions, it may be necessary to widen the definition of urban adaptation, to include a wider range of initiatives that contribute to building resilience in cities (Cities Climate Finance Leadership and Alliance 2024).

Encouraging private-sector investments and fostering public-private synergies are essential for securing sustainable financing for urban adaptation initiatives. Equally important is the engagement of both public and private financial institutions, which can help scale up investments in resilient infrastructure and nature-based solutions.

Adaptation actions focus on **increasing resilience to climate change impacts**, such as extreme weather events, rising sea levels, and changing precipitation patterns. Adaptation financing often includes grants for individuals or small and medium-sized enterprises (SMEs) to support localised

resilience measures, enabling communities to better prepare for and mitigate climate risks. For instance, the EU's LIFE programme provides funding for projects such as rainwater harvesting systems, flood-proofing homes, and green urban infrastructure. **National programmes**, like Italy's initiative for urban resilience, also provide financial backing for adaptation-focused projects. Financing these actions involves:

- **Public funding:** grants and subsidies provide essential financial support at minimal cost and without repayment obligations. They are available at all governance levels, allowing local authorities to fund priority projects. National grants, especially crucial in areas with limited market capacity, may face challenges like time constraints, limited funding, and alignment issues with local needs. They also focus on investments from EUR 500 000 upwards. Local funds address smaller amounts, such as those provided by the European Regional Development Fund and Cohesion Fund for climate adaptation.
- **Government financial and fiscal strategies**: national, regional, and local governments can enhance climate adaptation efforts by allocating additional funds within annual budgets and earmarking them for specific projects. This approach includes integrating climate adaptation into budgetary plans and applying **special taxes** or levies to individuals and businesses to generate dedicated funding, ensuring a sustainable revenue stream for crucial adaptation initiatives while promoting environmentally responsible behaviour. In addition, many countries have national climate funds to address their specific climate challenges.
- **Loans**: loans from banks and financial institutions are vital for securing initial capital for climate adaptation projects, especially when local governments face funding challenges. While loans facilitate large capital purchases, they require creditworthiness and involve interest costs, potentially increasing financial burdens. Institutions like the EIB play a key role in financing climate initiatives, providing specialised support for projects typically ranging from EUR 10-25 million and above [2].
- **Blended finance**: by combining public grants with private investments, municipalities can de-risk adaptation projects, such as flood defence systems, green infrastructure, and resilient agricultural practices. Several EU-funded programmes (e.g. the LIFE programme) have successfully harnessed private-sector capital to boost the impact of public funding, demonstrating the viability of partnerships in complex projects. These partnerships demonstrate the viability of blended finance in supporting complex and high-risk adaptation investments.
- **Climate resilience bonds**: these specialised bonds are issued to finance adaptation projects that protect communities and infrastructure from climate risks. For example, cities prone to flooding can use resilience bonds to fund improved drainage systems and wetland restoration. Similar examples include municipalities in the Netherlands issuing bonds to finance comprehensive water management projects (Economidou et al. 2021).

[2] https://www.eib.org/en/products/loans/index

— **Revolving funds:** these funds provide a sustainable funding mechanism for climate adaptation projects by requiring repayments that replenish the fund for future initiatives. They operate without fiscal year limitations, fostering market capacity and supporting projects in areas with underdeveloped credit markets. While they offer advantages like self-sustainability and flexibility, challenges include long repayment periods and variable fund sizes. Revolving funds are particularly suited for medium to large-scale projects with high capital and operational expenditures, typically ranging from EUR 1-5 million and above [3].

— **Insurance mechanisms:** innovative tools such as climate risk insurance and parametric insurance are increasingly recognised as key components of adaptation finance. These mechanisms allow cities and communities to transfer part of the financial risk associated with extreme weather events, enabling faster recovery and improving financial resilience. For example, parametric insurance provides rapid pay-outs triggered by specific climate indicators (e.g. rainfall thresholds or wind speed), without the need for damage assessments.

— **Multilateral development banks or climate funds**: institutions such as the European Investment Bank (EIB), the European Bank for Reconstruction and Development (EBRD), the World Bank and the Green Climate Fund are essential to adaptation finance. They provide grants, concessional loans, and technical assistance to support urban adaptation strategies, particularly in vulnerable areas.

— **Integrated planning and financing**: by integrating adaptation financing with urban development plans, municipalities can optimise the use of available funding and strengthen their eligibility for grants or loans destined for multi-benefit projects. For instance, projects such as green roofs and urban forests, which reduce heat island effects, improve biodiversity, and enhance air quality, can attract adaptation-focused funding while delivering co-benefits aligned with urban sustainability goals. This approach ensures that adaptation measures not only address climate risks but also maximise financial efficiency by aligning with broader public and private investment strategies.

— Other financing options: alternative sources of financing for climate adaptation include **PPPs**, **voluntary efforts**, **crowdfunding**, and **philanthropic funding**. PPPs blend public and private resources for large projects, balancing benefits with risks and costs. Voluntary actions harness community involvement and resources, while crowdfunding taps into citizen investments for small projects, offering quick funding but needing strong public engagement. Philanthropic funding provides non-repayable support for various initiatives, though it may be short-term and challenging to align with specific objectives [4].

Adaptation financing operates within a broader framework of public-private collaboration, reflecting the complexity of climate financing. For example, grants for citizens to install rainwater harvesting systems or flood-proofing homes showcase public sector support, while SMEs adopting climate-resilient technologies like drought-resistant crops or energy-efficient machinery often draw on both public grants and private investments, such as loans from banks or partnerships with ESCOs. Prioritising adaptation measures often yields high returns on investment, as they not only protect

[3] https://www.mase.gov.it/pagina/programma-sperimentale-di-interventi-ladattamento-ai-cambiamenti-climatici-ambito-urbano

[4] https://eu-mayors.ec.europa.eu/en/resources/funding_guide

infrastructure but also significantly reduce future costs associated with climate disasters. For example, the World Resources Institute reports that every USD 1 (approximately EUR 0.93) invested in adaptation generates USD 2 to USD 10 (approximately EUR 1.86 to EUR 9.30) in benefits, such as reduced repair costs for infrastructure and minimised economic disruptions from extreme weather events [5].

1.1.3 Financing energy poverty initiatives

Energy poverty, defined as the lack of access to affordable, reliable, and sustainable energy, is a critical issue for many municipalities. It not only refers to the inability to invest in energy efficiency or renewable solutions but also includes the difficulty in paying regular energy bills, which can lead to energy disconnection, debt, or restricted energy use, particularly in vulnerable households.

Individuals and SMEs can access national or regional schemes for energy financing, which often include incentives for energy renovation, as well as for renewable-energy solutions such as photovoltaic (PV) systems and electric vehicles. Tackling energy poverty requires:

- **Subsidised loans and grants**: programmes that involve soft loans and subsidies may be particularly beneficial for low-income households, enabling them to implement EE measures and put in place renewable-energy installations, such as solar panels. These programmes often include additional support, such as technical assistance and training, to ensure successful implementation.
- **Energy efficiency obligation schemes** (EEOs): under Article 7 of the Energy Efficiency Directive (EED), Member States are required to implement policy measures that deliver cumulative end-use energy savings. One of the most common approaches is to impose energy-saving obligations on energy distributors or retail companies, often requiring them to finance retrofits for vulnerable households. Several countries have developed robust national schemes for this. In Italy, the White Certificates (*Certificati Bianchi*) scheme has been a key tool for implementing EEOs, successfully supporting EE improvements across sectors, including social housing. In France and the UK, obligation schemes have successfully combined regulatory requirements with financial incentives to promote EE (Economidou et al. 2021). In France, these certificates are also a relevant source of funding for one-stop shops, contributing to integrated technical and financial assistance for vulnerable consumers.
- **Energy performance contracting** (EPC): through EPC schemes, energy service companies finance and implement EE improvements, with repayment linked to the cost savings achieved. Although more commonly applied to public buildings, EPCs can also support retrofitting in multi-family homes or social housing, enabling low-income residents to benefit from energy savings without upfront investment.

[5] https://blogs.lse.ac.uk/businessreview/2024/11/15/the-clock-cant-be-turned-back-on-climate-change-financing-adaptation-must-be-a-priority/#:~:text=Adaptation%20finance%20gap,%2410%20in%20net%20economic%20benefits

— **Social bonds**: municipalities may issue social bonds to fund projects that alleviate energy poverty, such as retrofitting public housing or subsidising energy bills for low-income families. These bonds not only provide financial support but also engage investors in addressing pressing social challenges.

— **One-stop shops (OSSs)**: OSSs, which are centralised service hubs providing streamlined access to resources and support, simplify access to financing and technical support for energy-poor households. They provide tailored advice, support grant applications, and coordinate with private-sector actors to deliver cost-effective solutions. An example is the HolaDomus project in Spain, which integrates technical assistance and financing options for vulnerable communities (Economidou et al. 2021).

— **Tax exemptions or reductions**: fiscal instruments such as reduced VAT on electricity or heating, property tax relief for energy-efficient renovations, or income tax deductions for vulnerable households can help alleviate energy costs and increase the affordability of energy services. These measures can complement direct subsidies by addressing recurring financial burdens.

— **Energy communities and cooperatives:** an energy community is a group of individuals, organisations, or entities that collaborate to produce, consume, share, or manage energy – typically from renewable sources– for mutual social, environmental, or economic benefits. These community-based models, often organised as cooperatives, promote local ownership, improve affordability, and foster active citizen participation in the energy transition. A notable example is the Melpignano [6] initiative in Italy, which encourages citizens to become active participants in renewable energy projects, addressing energy poverty while fostering community engagement.

Innovative approaches, such as leveraging environmental, social, and governance frameworks and community-driven initiatives, can increase the reach and impact of energy poverty programmes, ensuring equitable access to clean energy solutions. Community energy cooperatives, for example, empower individuals to collectively invest in renewable-energy projects, fostering ownership and resilience. Additionally, integrating energy poverty initiatives into broader urban planning strategies can create synergies with climate mitigation and adaptation goals, maximising social and environmental benefits.

1.2 Main challenges and solutions for municipalities

Implementing SECAPs presents municipalities with challenges of a financial, administrative, political, and technical nature. Addressing such obstacles is critical to achieving long-term sustainability goals and ensuring the successful implementation of SECAPs. The key challenges that municipalities have to overcome for the financing of SECAP actions (Rossi, Gancheva, and O'Brien 2017) are:

[6] https://www.coopcomunitamelpignano.it/

— **Lack of awareness about climate finance options:** many municipalities rely on traditional funding sources, such as public funds, and are often unaware of alternative and innovative financing instruments, including revolving funds, green bonds, and blending facilities. Existing initiatives like OSSs aim to bridge this knowledge gap by providing comprehensive information on available options, technical guidance, and strategies for managing innovative financial instruments. However, identifying suitable instruments can be particularly challenging for ongoing investments, as they may not meet specific funding requirements without proper categorisation.

— **Insufficient administrative capacity and technical knowledge:** it can be challenging to prepare applications and secure financing. Applications for centrally managed EU funds should be prepared in English, and may imply collaboration with organisations from other Member States, which would require significant time and effort. Unfortunately, smaller municipalities do not always have sufficient human resources and skills to prepare such applications. Insufficient administrative capacity is therefore a major obstacle in accessing climate finance at local level. It has been suggested that municipalities should build up in-house expertise in this area.

— **Budgetary and regulatory constraints:** as previously mentioned, the funds should be sufficient and available to invest. Preparing applications for EU funds or other financing instruments might require the hiring of new personnel or external consultants, which could be costly - especially for smaller municipalities. In addition, municipalities often do not consider last-minute expenses since they plan their financial needs many years before the project reaches completion. While local budgets are often limited, municipalities also face regulatory budget constraints, such as balanced-budget rules or debt limits, which can restrict their capacity to plan and implement long-term investments. However, regional or national authorities may provide financial support or co-funding mechanisms that help alleviate these constraints. Municipalities should therefore actively explore opportunities to leverage upper-level government programmes, especially those aligned with national climate and energy goals.

— **Political challenges:** changes in political leadership can disrupt long-term projects, especially when there is no cross-party consensus on sustainability goals. Political shifts may lead to a reallocation of funds or the cancellation of initiatives, undermining progress. Energy and climate strategies should be supported by broad political agreements that transcend election cycles, ensuring project continuity. However, the need to reach consensus among diverse political actors may also result in less ambitious targets, as compromise is often required to secure broad support.

— **Misalignment between local and national priorities**: in some cases, municipalities led by environmentally ambitious administrations may face difficulties in accessing EU or centrally managed national funds due to conflicting priorities with national governments. For instance, a green local agenda may not align with the priorities of a more conservative national government, limiting political support or administrative facilitation for funding applications. This misalignment can hinder project implementation, especially when national authorities act as intermediaries for EU funding. Strengthening vertical policy integration and enhancing cooperation between local and national levels are crucial to unlock access to resources and ensure coherence in climate action.

— **Creating bankable projects:** a bankable project is a well-documented and economically viable initiative. Developing a bankable project begins with identifying and organising the elements that make it economically attractive. Initially, it is essential to examine the project's key components, ensure each aspect is thoroughly assessed, and clearly present a plan for effective management of those components. Each component carries a risk factor, and each risk factor carries a price tag. An effective ESCO or financial consulting expert knows how to assess each part of a financial project. When a financing project is studied by a bank, the objective is to ascertain the level of risk by carrying out an assessment procedure. A technical energy audit is not enough. Other aspects, such as the engineering skills (of an ESCO or the municipal energy agency for instance) or the level of commitment of each party, are crucial for making the project attractive for the bank. For instance, some general requirements may be that the technology is well-proven, well adapted to the region and to produce an internal interest rate greater than 10%. Finally, to be attractive to investors, a project needs to have a sufficient scale: to this end, aggregating small projects (e.g. energy renovation of public buildings owned by small municipalities) can lead to the launch of concrete investments.

— **Complexity of EU and international funding requirements:** accessing EU or international funds requires compliance with strict eligibility criteria and thematic objectives. These prescriptive requirements often prevent the integration of complementary actions, such as combining EE, renewable energy, and sustainable mobility projects, or addressing different priorities, such as emission reduction and resilience. Simplified and flexible funding guidelines are essential to address this issue.

— **Limited integration of co-benefits in financial planning:** while local climate actions generate significant co-benefits, such as improved public health, job creation, and enhanced quality of life, these are often overlooked in financial planning. Including these considerations in cost-benefit analyses can help justify investments and attract more funding.

— **Need for multiannual commitments:** long-term projects often require multiannual financial commitments, which can conflict with annual budgeting cycles. Political changes exacerbate this issue, as new administrations may deprioritise ongoing projects. Sustained funding through cross-party agreements and robust financial planning is essential for achieving SECAP objectives.

To address the challenges of insufficient administrative capacity and limited knowledge of financing options, **OSSs** offer an effective solution. OSSs provide centralised access to technical assistance, information on funding opportunities, and streamlined processes for project implementation. By consolidating resources and expertise, they help municipalities navigate complex financing requirements and overcome barriers to entry, particularly for smaller municipalities with constrained resources. OSSs can also support municipalities in developing and implementing SECAP-related projects. Their services include guidance on procurement, regulatory compliance, project bundling, and access to tailored financial instruments.

Box 1. One-stop shops (OSSs) for energy renovation (Economidou, Todeschi, and Bertoldi 2019)

One-stop shops simplify access to financing and technical support for energy efficiency and renewable-energy projects. Acting as centralised hubs, OSSs foster collaboration among stakeholders and align resources to achieve energy transition goals. These OSSs can exist at various levels: at the national or EU level, where municipalities can seek funding and technical assistance, or they can be developed directly by municipalities to provide services to the public and local SMEs.

Key features: (i) *Comprehensive support*: OSSs provide tailored assistance for project preparation, grant applications, and access to innovative financing mechanisms, such as green bonds or EPCs; (ii) *streamlined*

processes: By serving as a single entry point, OSSs reduce administrative burden and accelerate decision-making, particularly for resource-constrained municipalities; (iii) *capacity-building*: OSSs provide training programmes to improve the technical and financial expertise of municipal staff, empowering municipalities to manage projects more effectively; (iv) public *engagement*: OSSs adopt inclusive approaches to involve communities in project planning and co-financing mechanisms, fostering trust and ensuring alignment with local needs.

Example

- At the regional level, **Île-de-France Énergies in France** [7] supports smaller municipalities by simplifying processes, optimising resource allocation, and promoting integrated renovation solutions. The agency not only assists individual households, but also coordinates with municipalities to develop energy renovation roadmaps and aggregated investment strategies.

- In **Ireland**, the **SuperHomes** [8] initiative, developed by Tipperary Energy Agency and Electric Ireland, provides an end-to-end OSS service to support deep energy renovations in residential buildings. It combines technical assessments, contractor coordination, and grant support, with the aim of delivering high-performance retrofits aligned with national climate targets.

- The **Turnkey Retrofit** [9] project, funded under the EU Horizon 2020 programme, developed integrated OSS models tailored to local contexts in France, Ireland, and Spain. For instance, in France, it built upon existing services like **Heero** and **Operene** to create a digital platform, **Solutions4Renovation**, offering homeowners a streamlined renovation journey – from initial assessment to financing and contractor engagement. This model was successfully adapted and implemented in Ireland and Spain, demonstrating the replicability of OSS frameworks across different national contexts (Volt, McGinley, and Delargy 2021).

Specifically, addressing **challenges associated with the financing of EE projects** requires a structured approach that considers every stage of the financing process. Municipalities must ensure that each phase – from project development to financing – is carefully planned and supported by adequate resources, expertise, and legal frameworks. By adopting a comprehensive approach, municipalities can increase the likelihood of project success while maximising financial and sustainability outcomes. While these phases primarily address EE projects, they can be adapted to other pillars of climate action. The fundamental steps –planning, tendering, guarantees, and financing– remain applicable, but the specific requirements, stakeholders, and financing instruments may vary. For instance, **adaptation projects** may prioritise infrastructure resilience, while **energy poverty initiatives** often emphasise community engagement and direct support for vulnerable households.

The four main phases of **EE project financing** are outlined below.

1. **Project development**: the local authority (LA) should be able to provide or obtain sufficient energy consumption data and street lighting maps; secure sufficient capital for upfront development costs; allocate staff resources specifically for the project; and ensure long-term commitment and stability.

[7] https://managenergy.ec.europa.eu/managenergy-discover/news/arec-ile-de-france-support-implementation-new-regional-energy-and-climate-strategy-fr-2023-04-19_en

[8] https://electricirelandsuperhomes.ie/

[9] https://www.turnkey-retrofit.eu/

2. **Tender requirement**: it is recommended that the LA has expertise in tender procedures, considering national, EU, and non-EU requirements; possesses the necessary design knowledge and technical expertise; and has thorough knowledge of procurement processes linked to energy performance and financing solutions.

3. **Obligations guarantee**: it is highly recommended that the LA be capable of securing high-quality guarantees provided by the ESCO/EPC or O&M (operations & maintenance) company; fulfilling obligations under the existing O&M structure; and ensuring a certain degree of savings assurance that outweighs the perception of risk.

4. **Financing**: it is highly recommended that the LA has sufficient capital to invest; ensures that the project has a positive financial and sustainable rating; addresses regulatory constraints; maintains a positive financial situation; and has the capacity to increase its debt level if needed.

Municipalities face several significant and distinct challenges and barriers in accessing **private adaptation financing** (Commission for the Environment - Climate Change - Energy 2024):

1. **Gaps in awareness and knowledge**: municipalities are often unaware of non-grant-based private financing options like blending facilities and green bonds. Moreover, fear of debt and financial risks discourages borrowing, as municipalities worry about repayment due to their lack of revenue stability.

2. **Capacity issues**: many municipalities lack the expertise to use financial instruments effectively and to navigate complex funding processes. Inadequate financial data hinders their ability to secure borrowing or leverage private funds. Smaller cities struggle with structuring PPPs and aggregating projects to attract financiers.

3. **Financial limitations**: projects are often too small to attract investors. Moreover, the transaction costs of bonds or PPPs can be prohibitively high. Limited creditworthiness and risk perception make attracting private investment challenging. Demonstrating project bankability is difficult due to uncertainty about return on investment.

4. **Governance and regulatory issues**: the complexity of financial instruments can be a deterrent to seeking financing. Regulatory and legal constraints, such as debt ceilings, restrict LAs' ability to raise funds and access international climate financing directly, forcing reliance on national authorities.

According to a study on Covenant signatories conducted across 148 municipalities in 17 EU countries, municipalities face a number of significant challenges (Venner et al. 2025):

— **Funding shortages**: over 85% of local administrations report that they have insufficient financial resources to implement climate adaptation measures, with more severe shortages reported in Southern Europe than in Northwestern Europe.

— **Insufficient staff capacity**: 73% of municipalities lack the necessary workforce to effectively plan and execute adaptation strategies, particularly in smaller towns with limited institutional capacity.

— **Lack of political support**: only 43% of local governments have adequate political backing for climate adaptation initiatives, impeding long-term planning and prioritisation of climate actions.

— **Barriers to access to funding**: municipalities face challenges in accessing funding, especially from private investors and international programmes, due to stringent conditions and requirements, with towns experiencing more difficulties than cities.

— **Limited involvement of vulnerable groups**: participation of vulnerable groups in adaptation planning is limited. This creates a risk of inequitable outcomes and neglecting the needs of those most affected by climate change.

To effectively address the challenges of climate adaptation, municipalities should take a multifaceted approach that combines cohesive adaptation principles (see study mentioned above) and both public and private financing strategies. Key solutions include:

1. **Cohesive adaptation and territorial cohesion**:
    - **Ensuring fair funding access**: municipalities should advocate for an equitable distribution of funds that considers their specific financial capacities and climate risk levels, ensuring those with greater needs receive more support.
    - **Empowering smaller urban areas**: by developing networks of smaller and medium-sized cities, municipalities can enhance their role in connecting rural regions to larger urban centers, fostering balanced growth and development.
    - **Leveraging financial tools**: making use of major financial instruments such as Cohesion Policy Funds, EIB loans, and national budgets would support comprehensive and large-scale climate adaptation initiatives.
2. **Attracting private financing**:
    - **Prioritising adaptation and allocating resources**: strong political commitment is necessary to ensure that adaptation is prioritised and that sufficient financial and human resources are allocated to these initiatives.
    - **Developing a clear adaptation strategy**: municipalities should draw up strategies that effectively identify and address climate risks, making use of tools like the Regional Adaptation Support Tool.
    - **Identifying funding options**: explore both public and private financing options, including green bonds, PPPs, and impact investment funds. Seek guidance from support services like the InvestEU Advisory Hub.
    - **Designing projects for private investment**: create projects that appeal to private investors by fostering an enabling environment through risk-sharing mechanisms such as PPPs and pooled procurement. Pooling projects can lower costs and improve efficiency, making them more attractive to investors.
3. **Capacity building**:
    - **Training and resources**: Ensure teams have the expertise to develop and implement successful adaptation projects. Seek training and capacity-building opportunities when in-house expertise is lacking and engage stakeholders effectively throughout the project lifecycle.

1.3 Overview of financing instruments

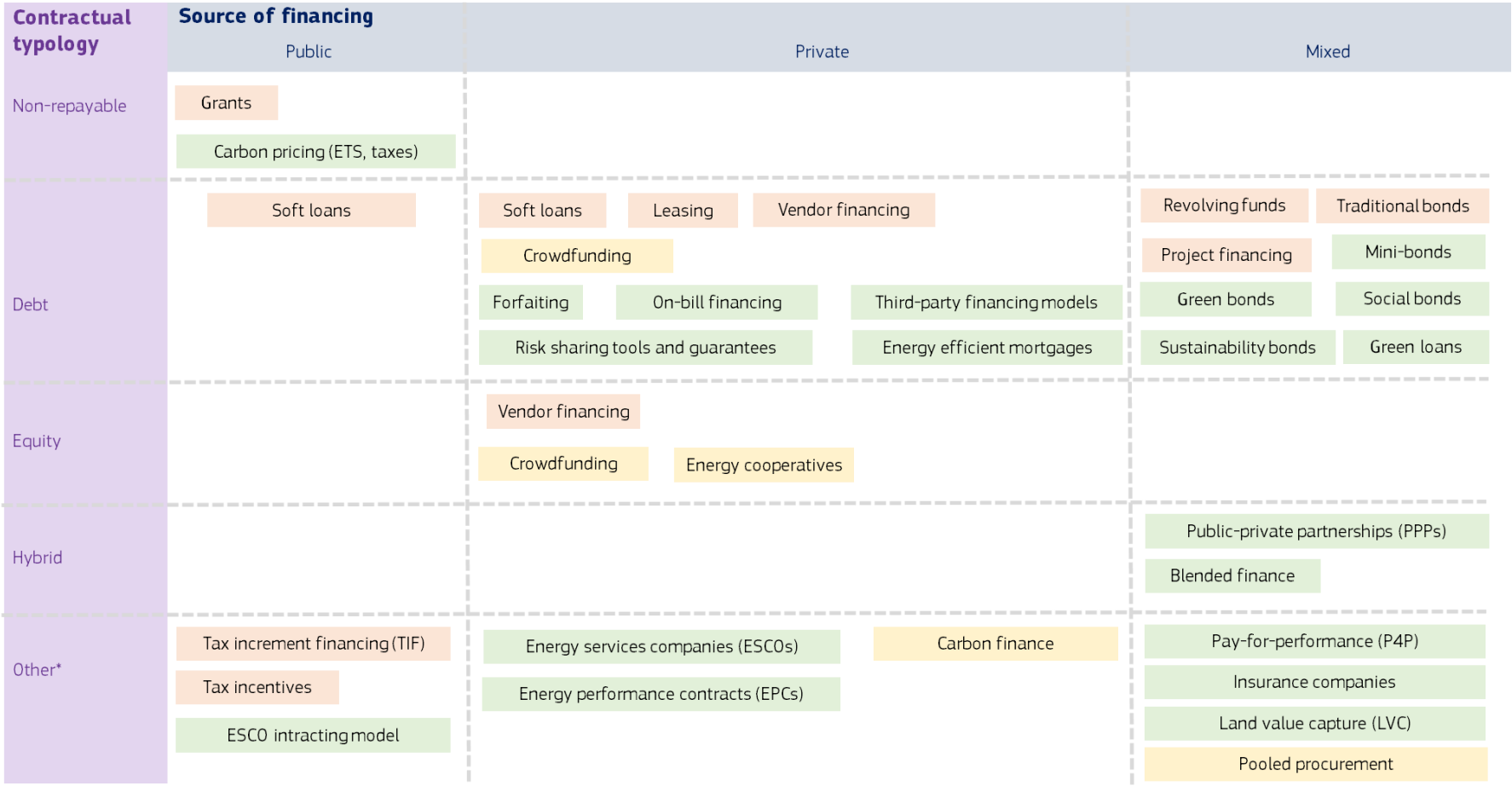
By carefully selecting the appropriate financing instruments, municipalities can overcome financial barriers. Financing mechanisms span traditional funding options, such as grants and loans, as well as more innovative and alternative models that attract private investment and foster community participation.

To provide a structured and comprehensive overview, in this document financial instruments have been classified based on three main criteria: sources of financing, contract types, and levels of innovation (Bertoldi et al. 2021; Bertoldi and Rezessy 2010; Economidou et al. 2019).

- **Sources of financing**: categorise instruments based on whether they are financed by the public sector, the private sector, or a mix of both.
- **Contract types**: distinguish between equity and debt agreements, with equity referring to investments made in exchange for ownership shares, and debt referring to loans or bonds that require repayment with interest. For municipalities, however, access to debt instruments is often limited by national or regional regulations that impose strict controls on public debt levels. These constraints may restrict the ability of municipalities to take out loans, especially in the absence of long-term financial commitments or strong credit ratings.
- **Innovation levels**: assess whether an instrument is traditional, innovative, or alternative, depending on its novelty, flexibility, and sustainability in addressing emerging challenges such as climate change and energy transition.

The choice of financing source, contract type, and level of innovation depends on the characteristics of the project, perceived risk, and long-term goals. While traditional models provide a solid foundation for more established projects, innovative and alternative instruments are essential for addressing emerging challenges and driving greater energy and climate sustainability. A strategic mix of these tools, combined with effective risk management and targeted financial planning, can provide the resources needed to successfully implement energy and environmental projects.

Figure 1. Overview of financing mechanisms, models and tools: classification according to sources of financing, contract type, and innovation levels.



Source: JRC elaboration

1.3.1 Sources of financing

Financing sources can be categorised as public, private, or mixed, each offering unique benefits and challenges. Integrating these sources effectively is key to overcoming financial barriers and scaling sustainable energy projects.

Public funds provided by national governments, municipalities, or international institutions like the EU, play a crucial role in supporting sustainability projects. These include grants, fiscal incentives (e.g. tax reductions), and soft loans. Public funding is particularly effective in covering the initial costs of long-term projects, such as EE and renewable-energy infrastructure. The European Green Deal supports urban climate action through programmes like Horizon Europe and the Just Transition Fund, the Renovation Wave (including the Renovation Fund), and other instruments like the Recovery and Resilience Facility and the ERDF. Additional support is provided via the LIFE programme, which funds nature-based and climate adaptation projects. Beyond the EU, multilateral banks such as the World Bank and the EBRD also play a significant role in financing EE and climate-related initiatives, particularly in European countries outside the EU, as well as in neighbouring and developing regions. These institutions offer grants, concessional loans, and technical assistance to support national and local sustainability strategies.

Private investments sourced from banks, investment funds, or individual investors, are essential for financing high-risk or innovative projects that public funds alone cannot support. These include debt instruments like loans, equity investments, and hybrid solutions like green bonds. Private investments offer additional resources and expertise but may prioritise projects with short-term returns, which could conflict with the long-term goals of sustainability.

Mixed financing models combine public and private resources, reducing financial risks and making projects more attractive to private investors. Examples include PPPs, which enable collaborative financing and management of infrastructure projects, and blended finance, where public funds de-risk high-stakes projects to attract private investments. A notable example is the EIB's role in co-financing urban sustainability initiatives through PPPs. While these models expand financing options, they require strong governance and negotiation skills to balance public and private interests effectively. Additionally, community-based funds, such as crowdfunding and energy cooperatives, are a hybrid form of financing that combines initial public support with direct engagement from the public and local stakeholders, fostering inclusion and participation in sustainable initiatives.

1.3.2 Contract types

Another critical aspect of financial models is the type of contract used, which can primarily be divided into **equity** and **debt contracts**. These two financing options are the key avenues for municipalities seeking to implement long-term energy sustainability and climate projects.

Both debt and equity financing offer opportunities to attract capital through borrowing and equity issuance, respectively. Debt financing involves obtaining capital with a commitment to repay the borrowed amount under specified conditions, often including interest payments. In contrast, equity financing involves issuing shares or equity stakes in the project, enabling investors to become partners who share both the risks and rewards.

However, both financing methods come with **limitations**. Debt financing requires repayment, which can become burdensome, especially if future cash flows are uncertain. Even with relatively low interest rates, debt repayments can strain the public budget, limiting the ability to invest in other

initiatives. Excessive debt can also jeopardise long-term financial sustainability, increasing the risk of insolvency. On the other hand, equity financing requires giving up some control over the project. Attracting investors for public projects can be challenging, as concerns about profitability and long-term risks –particularly in sustainability projects, which are often protracted– may deter potential investors.

In addition to equity and debt, other types of contracts can play a significant role in financing mechanisms, namely:

- **Hybrid contracts**: these combine elements of both debt and equity. For example, mezzanine financing allows for flexible repayment structures where loans may convert to equity if the project succeeds, providing additional incentives for investors.
- **Non-repayable contracts**: this category includes grants and subsidies, where funding is provided without the expectation of repayment. These are particularly important for supporting early-stage or high-impact projects that might otherwise struggle to secure private investments.
- **Other contracts**: this flexible category encompasses instruments that do not fit strictly into the repayment or ownership structures. Examples include performance-based contracts (e.g. pay-for-performance models) or insurance mechanisms that transfer or mitigate financial risks without a traditional repayment obligation.

1.3.2.1 Debt financing

Debt financing refers to the process of acquiring funds through borrowing. It entails a lender providing capital to a borrower for a specific purpose over a fixed period. In return, the borrower agrees to repay the principal amount, typically with interest, according to predetermined terms. This form of financing is common for large-scale public or private-sector investments, including infrastructure, energy efficiency, and sustainability projects.

Depending on the financial structure, debt financing can involve direct loans, project-based arrangements, or the issuance of debt securities. In some cases, repayment may rely on the expected cash flows generated by the project itself, while in others, more traditional credit structures are used.

Debt instruments may be structured with either recourse or non-recourse terms. In the former, the lender may claim the borrower's assets in case of default, while in the latter, the lender's claims are limited to the project's own assets or revenues. To improve creditworthiness and reduce risk, debt agreements may include guarantees, escrow mechanisms, or collateral provisions. Loan conditions can also be adapted to include grace periods, concessional interest rates, or tailored repayment schedules based on project performance.

Debt financing is particularly attractive for entities wishing to maintain full ownership and control of their projects. However, it also entails financial obligations that can strain public budgets, especially in the absence of stable revenue streams. For this reason, careful financial planning and risk assessment are essential to ensure long-term sustainability.

1.3.2.2 Equity financing

Equity financing refers to acquiring funds by issuing shares of common or preferred stock, typically in anticipation of income from dividends and capital gains. Equity can also refer to investments in private unlisted companies or start-ups. The equity investor's return is tied to the success of the business and may come from dividends or the appreciation in stock value.

Ownership equity can include preferred stock, common stock, capital surplus, and retained earnings, among others. This type of financing allows companies to raise capital without taking on debt, but it involves giving up a portion of control. Venture capital (VC), a sub-segment of private equity, involves investing in start-ups with strong growth potential. VC investors obtain equity shares and often play an active role in managing and guiding the company. However, VC investments typically require clear exit strategies, such as an initial public offering or company resale, to provide returns on investment (Bertoldi and Rezessy 2010).

Private equity is crucial for businesses seeking to expand, and several public agencies and funds provide equity investment opportunities for sustainable energy businesses and projects. Several public agencies and funds provide equity investment opportunities to support such initiatives. For instance, the *Marguerite Fund* [10], a pan-European infrastructure fund, continues to invest in energy, renewables, transport, and digital infrastructure projects across Europe. Its latest iteration, *Marguerite III*, launched in 2023, focuses on both greenfield and brownfield investments in sectors like renewable energy and clean transport. Similarly, SUSI Partners, a Swiss-based investment manager, offers funds such as the *SUSI Energy Efficiency & Transition Credit Fund* and the *SUSI Energy Transition Fund* [11], which provide financing for energy efficiency and sustainable infrastructure projects in Europe and other OECD markets.

1.3.2.3 Hybrid financing

Hybrid financing combines elements of both equity and debt. One example is mezzanine financing, where the investor provides capital that sits between debt and equity and may convert to equity if the project succeeds. Such hybrid solutions are valuable for bridging the financing gap between debt and pure equity, reducing risk for investors.

Mezzanine financing, or subordinated debt, is a hybrid form of financing that sits between senior debt and equity. It is considered riskier than senior debt because it is repaid after senior debt, making it a subordinate claim on project revenues. Mezzanine financing is typically provided by insurance companies, subordinated debt funds, or finance companies, and may involve high-yield bonds issued to institutional investors. It is often used to strengthen a project's financial structure, improving its creditworthiness and allowing it to raise additional senior debt or equity. The investor may also be granted stock options to acquire equity in the company.

In EE projects, subordinated debt helps address financing gaps and can be combined with senior debt and concessional funds, supporting the overall financing structure of the project. It is particularly useful when the project has stable cash flows and high growth expectations but may lack the equity base for traditional debt financing.

1.3.3 Level of innovation

The level of innovation of a financial instrument refers to the **novelty and sustainability of the tools** used, as well as their **ability to address emerging challenges** related to sustainability, such as climate change and energy resilience.

[10] https://www.marguerite.com/

[11] https://www.susi-partners.com/en/2024/10/susi-partners-secures-commitment-from-european-investment-fund/

Traditional instruments are those widely used for decades in financing projects, such as grants, soft loans, and traditional bonds. These instruments are typically lower risk and well-understood by both the public and private sectors. While useful for large-scale, long-term projects, traditional tools may not always meet the needs of particularly complex or high-risk projects.

Innovative instruments include those designed to address financing challenges more flexibly and in a modern way. Examples of these tools include green bonds, pay-for-performance models, and blended finance, which combine public and private resources. These instruments are considered innovative because they offer new ways to finance projects that address emerging sustainability challenges, such as climate change and urban resilience. These tools are designed to attract long-term investors, even when risks are higher.

Alternative instruments include financial models that promote direct community participation and the involvement of new actors in financing sustainability projects. Examples include crowdfunding, energy cooperatives, and carbon finance schemes based on voluntary carbon markets, which allow individuals and small businesses to invest in projects that improve EE and reduce GHG emissions. These tools are often seen as a response to the financial and political challenges of traditional systems, offering a more democratised and localised alternative to financing energy projects.

2 Traditional instruments

Traditional instruments have long provided a solid foundation for financing sustainability and energy efficiency projects. Widely used and well established, these tools offer reliable solutions to overcome the financial barriers that often hinder the initiation of ambitious initiatives by municipalities. With their proven effectiveness and structured approach, they are particularly suited for projects requiring significant investments or featuring extended payback periods.

Public funding mechanisms, such as grants, tax incentives, and soft loans, play a key role in supporting energy retrofitting projects and the development of renewable-energy infrastructure. Grants help alleviate the initial financial burden, making projects more accessible and attractive to private investors. **Tax incentives** provide targeted economic benefits to promote efficient technologies and sustainable practices, while **soft loans** offer favourable conditions that enable municipalities to plan larger-scale projects. Many **EU programmes** also fall under this category and are primarily grant-based. Notable examples include **Horizon Europe**, the **LIFE programme**, and **European local energy assistance** (ELENA), which offer funding and technical support for local sustainability initiatives that typically include an element of technological, financial, or governance innovation. These instruments often cover a significant share of upfront costs. The **private sector** also contributes with **flexible tools** like leasing and traditional bonds, tailored to meet the capital-intensive requirements of major projects. These mechanisms allow municipalities to access additional financial resources, **balancing risk and optimising investment opportunities**. Finally, **mixed financing models** combine public and private resources to address the limitations of stand-alone approaches. Instruments such as **revolving funds** and **project financing** not only reduce perceived risks for investors but also enable scaling up of more complex and innovative initiatives, enhancing the overall efficiency of investments.

The following sections will explore the characteristics, benefits, and challenges of each instrument, highlighting practical applications and their impact in different local contexts.

Table 1. List of traditional instruments: characteristics and description.

Scheme	Source of funding	Contractual typology	Description
Grant programmes	Public	Non-repayable	Organised programmes that allocate grant funding to various eligible projects or sectors.
Leasing	Private	Debt	Financing for equipment or infrastructure where the lessor retains ownership.
Project financing	Mixed	Debt	Financing for a project based on its future cash flows, often used for large infrastructure projects.
Public grants	Public	Non-repayable	Specific grants provided by public institutions to support targeted initiatives that benefit the public.
Revolving funds	Mixed	Debt	Funds that are replenished as loans are repaid, allowing for continued lending.
Soft loans	Mixed	Debt	Loans provided at below-market interest rates to support sustainable projects.
Tax incentives	Public	Incentive-based	Fiscal measures, such as credits or allowances, designed to encourage investments in specific sectors or technologies.
Tax increment financing (TIF)	Public	Incentive-based	A public financing method that uses future tax revenue from a specific area to finance infrastructure.
Traditional bonds	Mixed	Debt	Fixed-income securities issued by governments or corporations to raise capital.

Vendor financing	Private	Equity/Debt	Financing offered by the supplier for the purchase of goods or services.

Source: JRC elaboration

2.1 Public funds

Public funds are typically allocated by governments or public institutions and can take the form of investment grants, interest rate subsidies, and public grant programmes.

2.1.1 Grants

Grants are an essential tool for supporting EE projects as they provide financial assistance that **reduces the initial capital** burden. Grants aim to overcome financial barriers, especially in projects that require significant upfront investments, such as energy efficiency upgrades, renewable-energy installations, and infrastructure improvements.

2.1.1.1 Grant programmes

Investment grants or **interest rate subsidies** are frequently offered by governments to finance the initial costs of EE projects, which often face high upfront investment requirements and long payback periods. These subsidies play a pivotal role in enhancing the financial rate of return on such initiatives, making them more appealing to investors. By improving the cash flow of these projects, grants also facilitate greater access to additional financing, such as debt financing, which is critical for scaling up energy efficiency efforts.

This type of **grant support** is particularly valuable for municipalities and companies investing in large-scale infrastructure or technology upgrades, where the long-term benefits outweigh the significant short-term capital requirements. Beyond providing **financial relief**, investment grants help **reduce perceived risks for investors**, thereby making the sector more attractive. They are essential for leveraging **private-sector involvement**, especially in high-risk or innovative energy efficiency projects that might otherwise struggle to attract the necessary capital (Bertoldi and Rezessy 2010). Furthermore, grant programmes often include **direct financial support** or **subsidised loans** to enable the successful execution of sustainable projects.

Examples of grant programmes include national and EU-level initiatives aimed at fostering EE, renewable-energy deployment, support for low-income households, and climate adaptation efforts.

For example, in **Italy**, the National Energy Efficiency Fund supports energy retrofitting projects in public buildings and efficiency improvements in infrastructures. This fund provides concessional loans and guarantees to facilitate strategic investments, contributing to the achievement of the European energy efficiency targets. By addressing the upfront costs of such projects, the fund helps municipalities and other entities implement long-term energy-saving measures, ensuring financial sustainability while reducing GHG emissions.

Another example is the Planes de Impulso al Medio Ambiente (PIMA) programmes in **Spain**. These are government-led initiatives designed to finance projects that enhance the climate resilience of ecosystems, particularly in the agricultural and forestry sectors. The programmes focus on reforestation, sustainable land management, and the adoption of environmentally friendly practices. By providing targeted financial support, PIMA programmes accelerate actions that mitigate emissions, promote biodiversity, and strengthen the adaptability of key sectors to climate change impacts. These

programmes demonstrate how public funding can be tailored to address specific environmental challenges while supporting local economies (Rossi et al. 2017).

2.1.1.2 Public grants

Public grant programmes are implemented across the EU Member States to support EE projects that align with energy, social, and broader public policy goals. These programmes aim to facilitate the transition to sustainable energy systems and contribute to meeting climate targets at the national and regional levels.

Public grants offer several notable **advantages**. They play a key role in **raising awareness** about energy efficiency initiatives and sustainable infrastructures, **building trust** in these projects, and **encouraging** broader **participation among stakeholders**. For building owners and developers, the availability of subsidies can be a strong incentive to invest in EE measures, particularly when it comes to **retrofitting and renovating older properties**.

However, public grants are not without their **limitations**. One major challenge lies in their **often-constrained budgets**, whether at the EU or national level. This limitation can result in insufficient resources to meet the growing demand for energy efficiency projects, leading to stop-and-start funding cycles. Such interruptions hinder long-term planning and implementation, as potential beneficiaries may postpone their projects in anticipation of better funding conditions or upcoming grant opportunities. Another issue is the presence of **'free riders'** –individuals or entities that would have carried out the project even without the grant. This phenomenon makes it difficult to accurately evaluate the programme's effectiveness and can diminish the overall impact of the subsidy scheme.

To overcome these challenges, public grants should be integrated into comprehensive financing packages that **combine** various **public and private financial instruments**. This approach enables larger investment volumes and can help ensure more sustainable funding for EE projects and adaptation actions. In addition, the integration of grants with financial instruments like loans, guarantees, and private-sector capital can increase the scale and impact of energy efficiency investments (Bertoldi and Rezessy 2010).

In addition to grants, **other public support mechanisms** can enhance the financial viability of renewable energy and energy efficiency projects. For instance, **feed-in tariffs** – though not direct subsidies – have proven particularly effective in vulnerable communities by guaranteeing a stable and predictable revenue stream for renewable-energy production. This increases project bankability and complements grant schemes where upfront support alone may not be enough to attract investment.

Box 2. Home energy grants – Sustainable Energy Authority of Ireland (SEAI) (Rossi et al. 2017)

Location: Ireland

Year: Ongoing since 2002

Type of financial mechanism: Public grants

Objective: To promote energy efficiency (EE) and renewable-energy projects across various sectors, contributing to Ireland's sustainable energy transition.

Programme description: SEAI, Ireland's national sustainable energy authority, administers a variety of grant programmes targeting different sectors:

- *home energy grants*: financial support for homeowners to make energy efficiency upgrades, such as insulation, heating system enhancements, and renewable-energy installations.

- *electric vehicle grants*: incentives to encourage the uptake of electric vehicles and the installation of home charging infrastructure.

- *community grants*: programmes designed to support community-based energy projects, enabling groups to improve the energy efficiency of community buildings and facilities.

Results: SEAI's programmes have significantly contributed to Ireland's energy efficiency improvements. For instance, the Community Grant scheme has supported numerous projects, resulting in energy savings and more comfortable community facilities.

Challenges addressed: SEAI has tackled issues such as limited public awareness of energy efficiency benefits and the need for technical support in project implementation. By offering comprehensive grant schemes and technical assistance, SEAI has effectively engaged a broad range of stakeholders.

Lessons learned: Integrating grants with co-financing mechanisms and providing technical assistance are crucial for maximising the impact of public funds. SEAI's holistic approach serves as a model for leveraging public grants to stimulate private investment and achieve sustainable energy goals.

2.1.2 Tax incentives

Tax incentives can be a powerful tool to stimulate energy efficiency. They can include, for example, tax exemptions for investment in energy efficiency projects, and incentive regimes related to e.g. capital gain tax, property tax, VAT and accelerated or free depreciation.

Tax allowances are used, for instance, in the case of income tax deductions for investments in specific energy efficiency measures (e.g. insulation). They have the effect of a direct grant, but are administered via income tax declarations, without special grant applications. Accelerated depreciation on investments in specified equipment allows companies investing in energy-saving technologies to depreciate it at a faster rate, entailing lower corporate tax. The *Dutch Vamil* [12] scheme is an example of successful accelerated depreciation on designated equipment placed on a green fiscal list, thus bringing forward allowable costs, which can be used to offset against profits and improve cash flow. **France** also provides accelerated depreciation for industry.

Another form of tax allowance is the **tax credit**, whereby in addition to normal rules for tax allowance, a percentage of the investment cost of approved technologies can be used to offset corporate profit taxes. Exemptions of reduced rates of taxation on corporate profits are occasionally given to environmentally friendly activities. **Denmark** and **the Netherlands** use tax credits to encourage energy audits; **France** and **Italy** have established tax credits as a policy to promote EE. In **Italy**, for instance, the *Ecobonus* [13] scheme continues to provide substantial tax deductions (ranging from 50% to 65%) for a variety of energy efficiency measures in both residential and commercial buildings. The more recent *Superbonus* [14] scheme, which initially allowed for 110% tax deductions on deep renovation works (including insulation, heating system upgrades, and solar PV), has been progressively scaled down: the incentive was reduced to 70% in 2024 and is expected to fall to 65%

[12] https://business.gov.nl/subsidy/mia-vamil/

[13] https://ecobonus.mimit.gov.it/ (in Italian).

[14] https://www.agenziaentrate.gov.it/portale/superbonus-110- (in Italian).

in 2025, with stricter eligibility criteria and the removal of upfront discount mechanisms in many cases. These schemes function as **tax reliefs**, reducing the amount of income tax payable and serving as direct incentives for private investments in energy upgrades, particularly in the building sector.

A **regime of differentiated VAT** may, in practice, either encourage or discourage efficiency improvements. For instance, in some countries, VAT on district heating, natural gas and electricity may be reduced, while VAT on efficiency equipment and/or services may not be reduced. This discrepancy can negatively affect project economics (e.g. in **Hungary** and **Slovakia**). In other countries, VAT for environmentally friendly products and goods related to energy savings may be reduced (e.g. in **Czechia**). Under certain conditions, **property tax regimes** can demotivate owners from refurbishing their homes – in **Sweden** the calculation of the property tax is based on five categories, one of which is energy efficiency, so the better the performance of the property, the higher the property tax. In **France** the tax is calculated on the potential revenue if the property is rented. On the contrary, in **Czechia** house owners can get a real estate tax relief for five years if they reconstruct their heating system, switching from solid fuels to gas or renewable-energy sources, and in **Bulgaria** high efficiency residential buildings get a temporary exemption from property tax.

Governments can incentivise climate adaptation by applying special taxes or levies, and creating dedicated funds for climate initiatives. An example is **Greece's resilience tax** imposed on businesses and individuals, with the resulting tax revenues used to fund climate adaptation projects. This tax not only provides a sustainable revenue stream for necessary infrastructure and resilience programmes but also incentivises environmentally responsible behavior by linking the tax to the environmental impact of activities. Greece's approach demonstrates how aligning fiscal measures with climate goals can effectively support adaptation efforts while promoting sustainability. Another example comes from **Maspalomas, Canary Islands, Spain**, where fiscal regimes and **tax incentives** are designed to involve the private sector in financing nature-based solutions, thereby unlocking private investment for critical ecological projects. This initiative demonstrates how local financial structures can support climate adaptation.

2.1.3 Tax increment financing

Tax increment financing (TIF) is a financing tool that municipalities use to fund **public infrastructure** and **development projects**, including those aimed at improving energy efficiency and sustainability. TIF works by capturing the **future increase in property tax revenues** generated by a specific area's revitalisation or economic growth. These future tax revenues, which result from increased property values or enhanced economic activity, are then used to finance the upfront costs of public infrastructure projects.

This mechanism is particularly useful in areas that need revitalisation, where the initial costs of infrastructure upgrades or energy efficiency improvements might be prohibitive. By leveraging expected future growth, TIF **reduces the immediate financial burden** on local governments, allowing them to invest in projects that might otherwise be delayed due to budgetary constraints. TIF also **encourages private-sector participation** by creating a pathway for developers and property owners to benefit from the improved infrastructure and enhanced property values in the designated area.

TIF has been used effectively in **urban regeneration projects**, especially in areas where sustainable infrastructure and energy efficiency are priorities. For example, a local government might use TIF to

fund energy efficiency upgrades in public buildings, the installation of renewable-energy systems, or improvements to public transportation systems. The future tax increment generated by these improvements can then be used to repay the financing costs, creating a self-sustaining funding cycle.

2.1.4 Soft loans

Soft loans are financial instruments that offer **below-market interest rates** and **extended repayment periods**, often accompanied by **loan guarantees** to mitigate the risk of default. These mechanisms are essential for facilitating investments in energy performance contracting (EPC) and for supporting EE projects, which often involve high upfront costs and uncertain returns.

Soft loans provide long-term financial coverage to bridge the financing gap in the pre-commercialisation stages of EE initiatives. These instruments can include:

- **direct interest subsidies**, which lower financing costs for project developers;
- **risk premiums**, where international financial institutions or state entities guarantee part of the loan portfolio, reducing the risk for lenders;
- **capital contributions to revolving funds**, ensuring a sustainable flow of resources for future projects.

Loan schemes are widely used for EE measures and are structured with favourable conditions to make them more accessible to project developers. Common conditions include:

- **extended payback periods**, allowing borrowers to spread repayments over a longer time frame, reducing financial strain;
- **low or zero interest rates**, significantly lowering borrowing costs;
- **short-term interest deferral periods**, allowing project developers to stabilise operations before starting interest payments;
- **grace periods for repayments**, providing additional financial flexibility during the early stages of the project.

These features make soft loans an effective tool for overcoming financing barriers, increasing the feasibility of EE projects, and attracting additional private investment (Bertoldi and Rezessy 2010).

Box 3. Smart cities programme – Belfius, Belgium (Rossi et al. 2017)

Location: Belgium

Year: Launched on 4 June 2014

Type of financial mechanism: Soft loans

Objective: To support sustainable urban transformation projects, including energy efficiency improvements in public buildings and infrastructure.

Programme description: Developed in collaboration with the European Investment Bank (EIB), the programme offers below-market rate loans combined with EIB-backed guarantees to reduce financial risks. Projects include retrofitting public buildings, upgrading street lighting, and promoting near-zero-energy buildings and solar installations.

Results: (i) Approximately 120 projects analysed and 20 projects financed since the programme's launch, benefiting more than 1.4 million people; (ii) significant reductions in greenhouse gas emissions; (iii) enhanced financial and technical capacity for municipalities.

Challenges addressed: Risk aversion among municipalities and the need for technical capacity to implement energy-efficient projects.

Lessons learned: Combining low-interest loans with guarantees and technical support creates a robust framework for urban sustainability initiatives.

Box 4. Frederikshavn soft loan programme, Denmark (Cicmanova et al. 2017)

Location: Frederikshavn, Denmark

Year: Initiated in December 2014

Type of financial mechanism: Soft loans

Objective: To promote energy-saving measures in residential housing by combining energy efficiency with optional non-energy-related improvements.

Programme description: The city offers soft loans for all housing types, paired with energy advisors who develop tailored retrofit plans. The programme allows homeowners to implement improvements step by step, ensuring long-term flexibility and savings.

Results: (i) Increased homeowner participation in energy renovations; (ii) integration of energy-saving measures with other home upgrades.

Challenges addressed: Ensuring affordability and motivating homeowners to undertake energy-efficient retrofits.

Lessons learned: Offering flexibility and personalised support increases participation and effectiveness in residential energy renovations.

Box 5. Energy efficiency loans – Parma, Italy (Cicmanova et al. 2017)

Location: Parma, Italy

Year: Launched in 2014

Type of financial mechanism: Soft loans

Objective: To enable private homeowners to undertake ambitious energy renovations exceeding national standards.

Programme description: In partnership with Cariparma bank, the municipality created a soft loan scheme offering reduced interest rates for homeowners of single houses and condominiums. The initiative focuses on increasing energy efficiency and the use of renewable energy in dwellings.

Results: (i) Accelerated energy retrofits in private housing; (ii) enhanced collaboration between the municipality and the private sector.

Challenges addressed: High upfront costs of ambitious energy renovations.

Lessons learned: Tailored financing schemes aligned with local needs can effectively drive energy efficiency improvements in private housing.

2.2 Private financing

2.2.1 Leasing

The practice of leasing is how the market most commonly deals with the barrier of initial costs. Leasing is a way of **obtaining the right to use an asset** (rather than the possession of this asset). In many markets, finance leasing can be used for **EE equipment** -even when the equipment lacks collateral value. Leasing companies, often bank subsidiaries, have experience with vendor finance programmes and other forms of equipment finance that are similar to EE.

There are two major types of lease: **capital** and **operating**. The former usually concerns shorter term leases, while the latter transfers the risk to the lessee. Capital leases are instalment purchases of equipment. In a capital lease, the lessee owns and depreciates the equipment and may benefit from associated tax benefits. A capital asset and associated liability appears on the balance sheet. In operating leases, the owner of the asset owns the equipment and essentially rents it to the lessee for a fixed monthly fee. This is an off-balance sheet financing source. It shifts the risk from the lessee to the lessor but tends to be more expensive for the lessee [15]. Moreover, the period covered by the contract is shorter than the life of the equipment, and the lessor (investor) pays all maintenance and servicing costs.

Leasing is the most common form of vendor financing provided by manufacturers of equipment, and is often used for combined heat and power (CHP) equipment. Leasing is often done as part of a special purpose vehicle (Economidou and Bertoldi 2014).

2.2.2 Vendor financing (equipment supplier/vendor credit)

To support their marketing efforts, many general equipment manufacturers have established **either captive** or **third party vendor financing relationships**. Vendor financing helps the manufacturer sell its product by facilitating the financing of a customer's purchase. Vendor financing occurs when a financier provides a vendor with capital to enable them to offer 'point of sale' financing for their equipment. Under a vendor financing scheme there are **two types of arrangements**: one **between the vendor and the financier**; and the other **between the vendor and the customer**. The vendor/financier agreement sets out the terms that can be offered to the customer such as rates, length of term and necessary documentation. The vendor/customer agreement sets out the repayment terms of the loan. For energy-efficient equipment, these agreements can be structured in such a way that the customer payments are lower than the value of energy savings associated with the new equipment. If vendor financing is done by a third party, that party has typically done the work necessary to become comfortable with the technical aspects of the product, as well as its collateral value.

One example of vendor financing is the **OTP Bank-Tivi Street lighting programme** in **Hungary**. The International Finance Corporation has a Guarantee Facility Agreement with OTP supporting loans to small and medium-size cities to acquire Turnkey street lighting system retrofits. A vendor finance programme was successfully implemented with Tivi, a company specialising in municipal street

[15] https://www.leaseurope.org/

lighting. The OTP facility provided financing on a series of Tivi projects, using a fixed payment energy services agreement vendor finance structure (Bertoldi and Rezessy 2010).

2.3 Mixed financing

2.3.1 Traditional bonds

A bond is a **debt security**, in which the authorised issuer owes the holders a debt and, depending on the terms of the bond, is obliged to pay interest (**coupon**) and/or to repay the principal later, termed maturity. Thus, the issuer is the borrower (**debtor**), the holder is the lender (**creditor**), and the coupon is the interest.

An example of bond financing relevant to energy efficiency is issuing municipal bonds to procure funding for municipal energy efficiency. The city of **Varna in Bulgaria** issued **municipal bonds** to obtain financing for an EE project involving retrofit and modernisation of the city's street lighting. The bonds raised 3 million euro, and the simple payback of the project was two years and nine months. The municipality collected relatively high volumes of financing by issuing general obligation bonds at 9%. Repayment of the bonds was done in three equal portions during a three-year period, primarily as revenue bond emission through the savings. Six other cities participated in issuing bonds to raise funding for their projects (Bertoldi and Rezessy 2010).

2.3.2 Revolving funds

Revolving funds are financial mechanisms aimed at securing **sustainable financing for a series of investment projects**. These funds operate by reinvesting repayments from profitable projects into new initiatives, ensuring a **continuous cycle of funding**. After the initial capitalisation, revolving funds strive to become self-sustaining.

The primary objective is to finance projects with **short payback periods**, recover the investment, and then use the repaid funds to finance additional projects. These funds can be structured as a bank account under the owner's management or as a separate legal entity. Key features often include:

- **low or zero interest rates**, making the financing more accessible and cost-effective;
- **grace periods**, providing borrowers with additional time before periodic payments begin.

Revolving funds can also complement the operations of energy service companies by providing a flexible financing mechanism for their EE projects. There are **several parties** in a revolving fund: the **owners** can be either public or private companies, organisations, institutions or authorities. The **operator of the fund** can be either its owner or an appointed authority. **External donors and financiers** provide contributions to the fund in the form of grants, subsidies, loans or other types of repayable contributions. The **borrowers** can be either the project owners or contractors. According to the conditions of the revolving fund, savings or earnings gained from projects should be paid back to the fund within a fixed period, at certain time intervals [16].

[16] https://eu-mayors.ec.europa.eu/en/resources/funding_guide

The advantage of revolving funds is that they are **less dependent on external investors**. If they are run effectively, revolving funds can contribute to a permanent financing structure for energy efficiency investments, which is separate from political influence.

Typical disadvantages of using revolving funds in energy efficiency are that they **require substantial upfront investment** and might be cumbersome and expensive to administer. Yet, the later complexity is also inherent to subsidy schemes (Bertoldi and Rezessy 2010).

Box 6. Lithuanian Public Investment Development Agency (VIPA) (Rossi et al. 2017)

Location: Lithuania

Year: 2015

Type of financial mechanism: Revolving fund

Objective: To finance energy efficiency projects, particularly in municipal buildings and infrastructure, promoting sustainable development and reducing energy consumption.

Programme description: The Energy Efficiency Fund (ENEF), managed by VIPA, combines resources from the European Structural and Investment Funds (ESIF) with private investments to support energy efficiency initiatives. The fund focuses on modernising municipal buildings and infrastructure, such as energy-efficient street lighting. Repayments from funded projects are reinvested into new initiatives, ensuring a continuous cycle of financing.

Results: ENEF has successfully financed large-scale modernisation projects, including the refurbishment of public buildings and infrastructure, contributing to significant energy savings and enhanced financial sustainability for municipalities.

Challenges addressed: The fund reduces dependence on external financing and fosters self-sufficiency among municipalities, addressing challenges related to securing funding for energy efficiency projects.

Lessons learned: ENEF demonstrates the potential of revolving funds to create long-term impacts in the energy efficiency sector by maintaining financial sustainability and continuously reinvesting in new projects.

Box 7. SEAP Fund in Udine, Italy (Schäfer and Schilken 2017)

Location: Udine, Italy

Year: 2015

Type of financial mechanism: Revolving fund

Objective: To finance energy efficiency measures in public buildings, contributing to the goals outlined in Udine's sustainable energy action plan (SEAP).

Programme description: The SEAP Fund, initially known as the 'Climate Fund,' was established with an initial capitalisation of EUR 32 000, sourced from the city's budget income derived from energy efficiency credits (EECs) investments on the national energy market during 2007-2014. The fund is managed by the Municipal Agency for Environmental Policies, which operates similarly to an energy service company (ESCO). Municipal departments are invited to propose energy efficiency measures, which are evaluated based on cost-benefit analyses and predefined criteria. Approved projects are financed through the fund, with achieved financial savings redirected back into the fund to ensure its sustainability.

Results: The fund has successfully financed pilot projects, including: (i) lighting system renewal at Parco della Rimembranza (completed in 2015); (ii) lighting system renewal at Viale Palmanova overpass (completed in 2015); (iii) installation of new window frames at Forte infant school (completed in 2015); (iv) roof insulation

at Fruch primary school (completed in 2016). These projects have led to reduced energy consumption and CO_2 emissions, contributing to the city's sustainability goals.

Challenges addressed: The primary challenge was raising the initial funding due to the municipality's tight budgetary situation. By utilising income from EEC investments, the city overcame this hurdle and established a sustainable financing mechanism for energy efficiency projects.

Lessons learned: The SEAP Fund demonstrates that even small-scale initial investments can lead to long-term financial and environmental benefits. Establishing a revolving fund within the municipal budget architecture enables the continuous financing of energy efficiency measures, fostering self-sufficiency and reducing reliance on external funding sources.

2.3.3 Project financing

Project finance is **long-term financing** based upon the **projected cash flows** of the project rather than the balance sheets of the project sponsors. The financing is typically secured by all the **project assets**, including the **revenue-producing contracts**. Project lenders are given a lien on all these assets and can assume control of a project if the project company has difficulties complying with the loan terms (Bertoldi and Rezessy 2010).

In project finance, financiers have recourse to the project's cash flow and assets or additional collateral as securitisation. When making a secured loan, banks evaluate both the quality of the borrower and the collateral. Because smaller companies may not have sufficient internally generated cash flow or the debt capacity to borrow easily for general corporate purposes, they often turn to secured debt by offering collateral such as inventory and receivables or property, plant, equipment, or sometimes a bank letter of credit. Pledging collateral may allow such companies to obtain bank loans when they would not normally qualify for unsecured loans. The collateral is used to reduce a bank's loss in the event of a default on the loan (Bertoldi and Rezessy 2010). Unlike conventional debt financing that relies on an individual company's creditworthiness, project financing relies on a project's cash-flow expectations and spreads the risk between the different actors. Third party financing can be sought by an end user that is financing the project directly, or by an ESCO or similar entity that is carrying out the project. Projects initiated by ESCOs are largely project-financed and off the balance sheet of the company. Importantly, project finance is often based upon a **complex financial structure** where project debt and equity are used to finance a project, rather than the balance sheets of project sponsors.

Usually, a project-financing structure involves a number of **equity investors**, as well as a **syndicate of banks** that provide loans to the operation. The loans are most commonly non-recourse loans, which are secured by the project assets and paid entirely from project cash flow, rather than from the general assets or creditworthiness of the project sponsors, a decision in part supported by financial modelling.

The ratio of debt to equity is much higher in project finance than in 'on balance sheet' corporate financing: as indicated, a project with 70-80% debt and 20-30% equity is common in project financing. Compared to on balance sheet finance, banks will usually be willing to extend the length of the project finance loans to almost 15 years because they have much more control over the project. Another particularity of project financing is that it **transfers the risk** away from the financiers and spreads it among the different actors. Through contracting and because risk is divided between the different sponsors of the project, project financing ensures that there are different outcomes in cases of non-payment (Bertoldi and Rezessy 2010).

A **special purpose vehicle** (SPV) – also referred to as special purpose entity – is a firm or other legal entity established to fulfil some narrowly defined or temporary purpose, which facilitates off-balance sheet financing of projects. SPVs are used in a variety of transactions, including securitisations, project finance, and leasing. An SPV can take various legal forms, including corporations or partnerships. A standard approach is to form a SPV and place assets and liabilities on its balance sheet. The investors (a.k.a. sponsoring firms) accomplish the purpose for which an SPV has been set up –for example implementing a large EE project– without having to carry any of the associated assets or liabilities on its own balance sheet (Bertoldi and Rezessy 2010).

Because a typical project finance structure includes a wide array of contracts between the different actors that transfers the risk and provides sufficient risk coverage and an appropriate division of risks, project financing is associated with **large transaction costs** and **intricacies** that imply a very high threshold investment price, typically above 10 million euro.

EE finance marketing will prosper where lenders can make credit decisions based on free cash flow and ability to pay and include a prudent portion, e.g. 70% of estimated energy cost savings in these calculations. Many development financial institutions (DFIs) offering guarantee-based finance programmes emphasise the importance of helping partner financial institutions structure secure transactions that require less additional collateral from borrowers, and instead underwrite loans based on the project's expected benefit stream and the borrower's ability to pay.

Off-balance sheet financing is attractive from a risk management standpoint. When assets and liabilities are moved from one balance sheet to another, the risks associated with those assets and liabilities go with them. Off-balance sheet financing also affords considerable flexibility in financing. Most importantly from the standpoint of EE project financing, an SPV does not utilise the sponsoring firm's credit lines or other financing channels. An SPV is presented to financiers as a stand-alone entity with its own risk-reward characteristics. It can issue its own debt or establish its own lines of credit. Often, a sponsoring firm overcapitalises an SPV or supplies it with credit enhancement. In this circumstance, the SPV may have a higher credit rating than the sponsoring firm, and it will achieve a lower cost of funding. Cogeneration projects are often implemented by ESCOs and frequently structured through an SPV set up by investors. The sponsor establishes a SPV with the objective to own and operate a cogeneration system. Assets of the company are represented by the co-generator facilities, and investment return is assured by two revenue streams: one is heating sales to end-user companies (approx. 10-20%) and the other is electricity sales to the grid (approx. 80-90%), sometimes based on a preferential CHP feed-in tariff. The borrower is the SPV (Bertoldi and Rezessy 2010).

3 Innovative instruments

In a context of limited financial resources, innovative financing models offer **creative and flexible solutions** for municipalities seeking to implement EE, sustainability and energy poverty projects. These models draw on **private capital**, **stakeholder engagement**, and **performance-based returns** to overcome financial barriers, reduce risks, and accelerate the implementation of projects that might otherwise be hindered by budget constraints.

This chapter explores the main innovative financing models, highlighting their potential to attract investment, reduce risks, and accelerate the implementation of SECAPs. While offering numerous benefits, these models require a **well-planned approach**, as they often involve increased **complexity** in managing and measuring results, as well as greater **interaction** with private partners and investors.

Table 2. List of innovative instruments: characteristics and description.

Scheme	Source of funding	Contractual typology	Description
Blended finance	Mixed	Hybrid	Combining public and private-sector funding to achieve greater impact in financing sustainability projects.
Blue bonds	Mixed	Debt	Bonds issued to support ocean and waterway conservation and sustainable maritime activities.
Carbon pricing (ETS, green and white certificates, taxes)	Public	Market-based	Systems where carbon emissions are taxed or traded, providing incentives for reducing emissions.
Climate bonds	Mixed	Debt	Bonds aligned with climate goals, financing projects like renewable energy, mitigation and adaptation.
Climate resilience bonds	Mixed	Debt	Bonds dedicated to financing projects aimed at increasing climate resilience in vulnerable areas.
Energy-efficient mortgages	Private	Debt	Mortgages that offer better terms for purchasing energy-efficient homes or making energy upgrades.
Energy performance contracts	Private	Performance-based contracts	Agreements where energy efficiency upgrades are paid for through future energy savings.
Energy services companies (ESCOs)	Private	Performance-based contracts	Companies that finance energy efficiency projects and receive payments based on energy savings.
ESCO 'intracting' model	Public	Performance-based contracts	Internal financing model for energy efficiency projects within public entities.
Forfeiting	Private	Debt	A financial transaction where a business sells its receivables at a discount to raise immediate cash.
Green bonds	Mixed	Debt	Bonds issued to fund projects with environmental benefits, such as renewable-energy infrastructure.
Green loans	Private	Debt	Loans with favourable terms to support environmental projects, such as renewable-energy installations.
Insurance mechanisms for climate adaptation	Mixed	Risk transfer tools	Insurance products that mitigate financial risks from climate disasters, such as parametric insurance or catastrophe bonds.

Land value capture (LVC)	Public	Revenue-based	A method where increases in land value due to public investment (e.g. infrastructure) are captured and reinvested in additional sustainable projects.
Mini-bonds	Mixed	Debt	Small-scale bonds issued by SMEs or municipalities to raise capital for infrastructure, energy efficiency or sustainability projects.
On-bill financing	Private	Debt	Financing where the cost of energy efficiency upgrades is paid back through utility bills.
Pay-for-performance (P4P)	Mixed	Outcome-based	Payment models where compensation is based on the achievement of specific energy or environmental outcomes.
Public-private partnerships (PPPs)	Mixed	Hybrid	Collaborative arrangements between the public and private sectors to finance and manage public infrastructure projects.
Risk-sharing tools and guarantees	Private	Debt	Instruments designed to mitigate risk for investors, often through partial guarantees or insurance.
Social bonds	Mixed	Debt	Bonds used to fund projects with social outcomes, such as affordable housing or healthcare.
Sustainability bonds	Mixed	Debt	Bonds that combine funding for both environmental and social projects, aligning with the Sustainable Development Goals (SDGs).
Third party financing models	Private	Debt	Financing arrangements where a third party provides upfront capital for projects, typically in energy efficiency.

Source: prepared by the JRC.

3.1 Public funds

3.1.1 Carbon pricing

Carbon pricing is a **market-based mechanism** aimed at assigning a monetary value to GHG emissions, effectively internalising the **environmental cost of carbon-intensive activities**. By making emissions more expensive, carbon pricing creates financial incentives for businesses, governments, and individuals to shift towards cleaner, low-carbon alternatives. The two main forms of carbon pricing are **emissions trading systems** and **carbon taxes**.

Other complementary mechanisms include **green certificates**, which promote renewable-energy generation, and **white certificates**, which reward verified energy savings – both of which contribute to market-driven decarbonisation alongside ETS and carbon taxes.

3.1.1.1 Emissions trading systems

An emissions trading system (ETS), also known as a **cap-and-trade system**, sets a total maximum limit on allowable greenhouse gas emissions and allocates or auctions emission permits to companies. These permits can be traded on the market, incentivising emission reductions where it is most cost-effective. These systems are particularly effective in **driving innovation** and **encouraging investments in cleaner technologies** as companies strive to reduce their emissions.

ETS schemes have been adopted globally with varying levels of success. For example, the European Union Emissions Trading System (EU ETS) is one of the largest and most established systems, covering approximately 40% of the EU's GHG emissions. By placing a monetary value on carbon emissions, the EU ETS creates a financial incentive for industries to transition towards greener

practices. Several major cities have also implemented local ETSs. Notably, **Tokyo** [17] was one of the first cities to launch an urban cap-and-trade programme for large commercial and industrial buildings.

Recent progress on Article 6 of the Paris Agreement paves the way for the creation of international carbon markets. These markets allow for the trading of emission credits, promoting greater transparency and global cooperation in reducing emissions.

3.1.1.2 Green and white certificates

In addition to ETSs, other market-based mechanisms such as green and white certificate systems help support decarbonisation and energy efficiency goals.

In **Belgium**, the **green certificates system** represents an innovative mechanism to incentivise renewable-energy production. Producers receive certificates for every MWh of electricity generated from renewable sources. These certificates can be sold to grid operators, who are legally obliged to purchase a certain volume at a guaranteed minimum price. This system not only promotes renewable energy but also creates a secondary market that drives further investments in the sector (Gancheva, Markowska, and O'Brien 2019).

White certificate schemes, implemented in countries like France and Italy, function in a similar way by certifying verified energy savings, which can be traded among obliged entities to meet efficiency targets.

The combination of ETSs and green and white certificates exemplifies how market-based mechanisms can work in synergy to achieve environmental and energy objectives.

3.1.1.3 Carbon taxes

Carbon taxes impose a fixed cost per tonne of CO_2 emitted, providing a clear and predictable price signal that encourages emission reductions. Unlike an ETS, which operates with a cap on emissions, a carbon tax does not limit the total amount of emissions but **incentivises changes in behaviour** and **drives investments in cleaner technologies**.

Sweden [18] was one of the first countries to implement a carbon tax, which has significantly influenced emission reductions and fostered investment in renewable energy. The tax is levied on fossil fuels, with the revenue being reinvested into the economy, often to support clean energy projects. The predictable price signal encourages businesses to reduce their carbon footprint by adopting more sustainable practices.

France also imposes a carbon tax on fossil fuels, which has been a central component of its efforts to reduce carbon emissions and finance climate-related initiatives. The tax incentivises the shift to low-carbon energy sources by making high-emission options more costly. France uses part of the revenue generated from the carbon tax to fund energy transition programmes, as well as providing direct financial transfers to low-income households to mitigate social impacts. This approach

[17] https://www.c40.org/case-studies/tokyo-s-urban-cap-and-trade-scheme-delivers-substantial-carbon-reductions/.

[18] https://www.government.se/government-policy/taxes-and-tariffs/swedens-carbon-tax/.

demonstrates how carbon taxes can effectively balance **environmental goals** with **economic equity** (Teodoru et al. 2024).

Ireland has implemented a progressively increasing carbon tax, with revenues explicitly ring-fenced to fund energy efficiency upgrades and alleviate energy poverty. For instance, in Ireland's 2024 budget, EUR 380 million from carbon tax receipts was allocated to residential and community energy retrofit schemes, including the *Warmer Homes Scheme*, which provides free energy efficiency upgrades to households in or at risk of energy poverty [19]. This approach has contributed to a relatively high public acceptance of the carbon tax, as the revenues are used transparently to support vulnerable households and promote sustainable energy practices.

Carbon taxes provide a direct incentive for sustainable investments. In contexts where national schemes are lacking, cities can introduce local pricing mechanisms to support climate action – particularly in the transport sector – such as promoting public transport and low-emission zones. Integrating local fiscal measures, such as **congestion charges** and **parking fees**, is a practical example of municipal-level carbon-related revenue generation. These instruments can be designed to reflect emissions performance or geographic areas, thereby reinforcing behavioural change. For example, congestion charges in cities like **London** and **Milan**, and parking fees that vary based on vehicle emissions or urban zones, not only reduce traffic and pollution but also generate revenues that can be reinvested in sustainable urban mobility and climate mitigation projects. By combining carbon-pricing tools with complementary measures, such as targeted financial support and reinvestment into renewable energy, governments can create a more sustainable and equitable path towards decarbonisation.

Box 8. Local carbon pricing through the Climate Mobilization Act - Local Law 97 [20] (LL97)

Location: New York City, United States

Year: Law adopted in 2019, effective from 2024

Type of financial mechanism: Local carbon-pricing mechanism (carbon tax equivalent)

Objective: To reduce GHG emissions in the building sector by promoting energy efficiency and renewable-energy investments.

Programme description: LL97, part of the broader Climate Mobilization Act, is considered one of the most ambitious municipal climate laws in the world. The law sets annual GHG emissions limits for most buildings larger than approximately 2 300 m^2, covering around 50 000 buildings citywide. From 2024, these buildings must comply with progressively stricter emissions caps. Owners who exceed their assigned emissions limits are subject to a financial penalty of approx. EUR 250 per tonne of CO_2 equivalent, effectively functioning as a local carbon tax. Although not formally defined as a tax, LL97 operates as a carbon-pricing mechanism, creating strong financial incentives for energy efficiency upgrades, electrification and investment in renewable-energy systems. Revenues can be reinvested in local climate initiatives.

Results: LL97 has triggered a wave of retrofitting efforts and spurred the development of new compliance tools and emissions tracking technologies.

[19] https://www.gov.ie/en/department-of-the-environment-climate-and-communications/press-releases/minister-ryan-delivers-record-1159-billion-investment-in-budget-2024-to-support-families-communities-and-a-net-zero-future//.

[20] https://www.nyc.gov/site/buildings/codes/ll97-greenhouse-gas-emissions-reductions.page/.

Challenges addressed: Resistance from building owners, complexity in calculating actual emissions, and the need for technical and financial support to ensure compliance.

Lessons learned: Regulating the building sector through carbon pricing can generate significant long-term impacts, but requires strong governance, robust monitoring tools, and complementary support measures to ensure equity and feasibility.

3.2 Private financing

3.2.1 Energy services companies

Energy services companies (ESCOs) usually finance **energy-saving projects** without any upfront investment costs for the LA. The investment costs are recovered, and a profit is made from the energy savings achieved during the contract period. The contract guarantees a certain amount of energy savings for the municipality and provides the possibility for the municipality to avoid facing investments in an unknown field. Once the contract has expired, the city owns a more efficient building or new energy plant, which will imply less energy costs.

Often, the ESCO offers a performance **guarantee** which can be shaped in several forms. The guarantee can revolve around the actual flow of energy savings from a retrofit project. Alternatively, the guarantee can stipulate that the energy savings will be sufficient to repay monthly debt service costs. The key benefit to the building owner is the removal of project non-performance risk, while keeping the operating costs at an affordable level.

Third party financing schemes – where an external entity covers the upfront investment costs and is repaid through the project's savings – are a common structure used in the ESCO model. These schemes are particularly useful for municipalities that lack the capital to implement energy efficiency and sustainability projects. Financial institutions or private entities bear the financial risk and provide the funding, while the public authority repays the investment through the savings generated over time. This structure reduces the financial burden on the public authority, while allowing the project to proceed without upfront resources.

Energy performance contracting (EPC) is one of the most commonly used instruments under this model. An EPC is a contractual agreement between a beneficiary and an ESCO, which implements energy efficiency or renewable-energy improvements and provides the necessary expertise and monitoring throughout the contract. The ESCO is only paid if the project achieves the agreed savings or energy output (Bertoldi and Rezessy 2005). Financing is arranged so that the energy savings cover the cost of the contractor's services and the investment cost of the new and more energy-efficient equipment. The repayment options are negotiable and depend on the project structure and the performance achieved.

Perhaps the easiest way for municipalities to undertake comprehensive building energy retrofits is to shift capital and performance risk to a third party. With these innovative methods of financing, high financing costs may be expected to reflect the fact that the debt is recorded on someone else's balance sheet. However, the interest rate is only one factor among many that should be considered in determining the suitability of a project-financing vehicle (Bertoldi and Rezessy 2010).

Measurements and verification of the energy and savings produced are critical for all the parties involved in the project. To ensure transparency and trust among buyers, sellers and financiers, a protocol aimed at working with common terms and methods is essential. The **International Performance Measurement and Verification Protocol** is an international set of standardised

procedures for the measurement and verification of savings in EE projects (also in water efficiency). This protocol is widely accepted and adapted [21].

ESCO financing structures can employ limited-recourse project finance, often requiring additional collateral or credit support. There are numerous techniques to secure energy efficiency (EE) equipment and project loans for end users. These include mechanisms such as preferred drawing rights, dedicated escrow accounts, reserve funds, security interests in equipment and project assets, recourse to the equipment vendor, repayment via utility bills or property taxes, additional collateral from the borrower, as well as guarantees and credit enhancement programmes (Barbosa et al. 2018).

Local carbon taxes can further support the ESCO model by creating stronger economic incentives for energy efficiency. By increasing the cost of carbon-intensive energy sources, these taxes encourage both public authorities and private actors to invest in clean energy solutions and turn to ESCOs for expert implementation and guaranteed savings.

Box 9. Frederikshavn third party financing and soft loans scheme (Cicmanova et al. 2017)

Location: Frederikshavn, Denmark

Year: Since 2017

Type of financial mechanism: Soft loans and third party financing

Objective: To support residential energy renovation by combining accessible financing with technical assistance, thereby removing financial and organisational barriers for homeowners.

Programme description: In Frederikshavn, a third party financing model was implemented alongside soft loans and independent advisory services. Homeowners received tailored support from advisors who developed detailed, step-by-step renovation plans that included both energy-saving measures and optional non-energy improvements (e.g. home expansions). The flexibility of the model, allowing for incremental implementation, was key to its success.

Results: The approach enabled widespread homeowner participation in energy renovation by addressing upfront financial constraints and simplifying project organisation.

Challenges addressed: The scheme effectively tackled both the lack of financial resources and the complexity of planning and managing renovation projects.

Lessons learned: Combining soft loans with trusted technical support enhances the attractiveness and feasibility of home renovation, particularly when flexibility and personalised planning are provided.

3.2.1.1 Public internal performance commitments (ESCO 'intracting' model)

In addition to the large private ESCO sector, a **public ESCO** sector called **public internal performance commitments (PICO) or the 'intracting (internal contracting) model'**, has mainly been used in **Germany**. In the PICO model, a department within the public administration acts like an ESCO, providing services to another department. The ESCO department organises, finances and implements energy efficiency improvements mostly through a fund made up of municipal money, and using existing know-how. This allows for **larger cost savings** and **implementation of less**

[21] https://www.evo-world.org/en/.

profitable projects, which would be ignored by a private ESCO. However, these projects **lack the energy savings guarantee**, because there are **no sanction mechanisms** within a single organisation (even though PICO includes saving targets). This can result in less effective investments, but the scheme may still lead to an increase in the number of energy-saving initiatives.

The **strengths** of the **internal contracting model** compared to external contracting are numerous and can be particularly advantageous for public administrations (Schäfer and Schilken 2017). First, **project implementation** can be **faster**, as there is no need for the selection and negotiation process with external actors. Additionally, since there is no profit mark-up as seen in contracts with private companies, the overall costs of the project can be lower, making the model more cost-effective.

Another important advantage is that there is **no cherry-picking of projects**, which is often the case with private ESCOs that tend to select only the most profitable interventions. In the PICO model, less profitable but equally important projects for energy efficiency can also be addressed. There is also greater flexibility in financing projects partially or supplementarily, making the system more adaptable to different needs.

From a management perspective, the internal contracting model **simplifies the monitoring** of results. Since all the departments involved are within the same administration, it is easier to track the progress of projects and ensure that energy savings targets are met.

Moreover, the PICO model helps **overcome some structural barriers** typical in public administrations, such as administrative restrictions and fixed budgets, which could otherwise hinder the initiation of EE projects. It also **avoids conflicts of interest**, which often arise when a public entity has to negotiate with external suppliers, making the process more transparent and streamlined.

Strategically, using an **internal contract linked to a revolving fund** ensures continuous funding for energy-saving projects. The revolving fund allows resources to be concentrated on improving energy efficiency, using renewable energy, and combating climate change. This approach enables integrated resource management, strengthening a holistic view of the investments needed to reduce energy costs and improve long-term sustainability.

Box 10. Internal contracting in Stuttgart – Stuttgart Environmental Agency (Rossi et al. 2017; Schäfer and Schilken 2017)

Location: Stuttgart, Germany

Year: Initiated in 1995

Type of financial mechanism: Internal contracting with a revolving fund

Objective: To pre-finance energy efficiency and water conservation measures, promoting sustainability in public buildings.

Programme description: The Stuttgart Environmental Agency implemented the 'intracting' model to finance and manage energy efficiency projects. This system uses a revolving fund, where savings achieved from implemented measures are returned to the agency from the energy budgets of public departments until the initial investment is fully repaid. The funds are then reinvested in new projects, eliminating the need for private-sector profits. Projects funded range from small-scale improvements, such as upgrades to control technology, to large-scale initiatives like the installation of wood-pellet heating systems.

Results: Since 1995, over 220 projects have been implemented, with a total investment of approximately EUR 8.1 million. Annual savings amount to EUR 1.2 million, equivalent to 32 000 m^3 of water, 15 000 MWh

of thermal energy, and 2 000 MWh of electricity. Additionally, 27% of investments have been directed towards renewable-energy projects. The average payback period for the investments is seven years.

Challenges addressed: The model helped overcome administrative and budgetary barriers that previously hindered energy efficiency projects. It also avoided conflicts of interest through internal management and financing.

Lessons learned: The internal contracting model has proven to be an effective and cost-efficient alternative to external contracting. The revolving fund ensures sustainable financing for energy efficiency initiatives. Transparency, flexibility and the absence of private-sector profit margins make this approach particularly suitable for public administrations.

3.2.1.2 Energy performance contracts

Energy performance contracts enable municipalities to collaborate with ESCOs to design, implement, and finance EE measures. Under this model, the ESCO invests in the project and recovers its costs through the energy savings achieved, thereby minimising the financial burden on the public authority. The **ESCO guarantees energy savings**, with repayments structured according to the actual savings achieved over time. This financing approach allows public authorities to undertake EE projects **without upfront capital**, while ensuring that the energy savings generated are sufficient to cover the costs of implementation.

Box 11. Energy Performance Contracts in public lighting – province of Huelva, Spain (Stelmakh and Novikova 2017)

Location: Spain, province of Huelva

Year: 2015-2016 (project initiation), 12-year contract duration

Type of financial mechanism: Energy performance contract (EPC) with guaranteed savings

Objective: To upgrade public lighting systems to reduce energy consumption, minimise maintenance costs, and enhance efficiency in small municipalities.

Programme description: The province of Huelva, consisting of 79 municipalities – many with populations under 5 000 – faced challenges with outdated lighting infrastructure, high energy usage, and elevated operational costs. To address these issues, the provincial government adopted an EPC model with guaranteed savings. A bundled procurement strategy was implemented, combining multiple municipal lighting projects into a single tender to benefit from economies of scale and attract energy service companies (ESCOs).

The selected ESCO, Gamma Solutions SL, signed a 12-year contract and undertook the following actions:

- *lighting upgrades*: replaced all traditional lighting systems with energy-efficient LED technology;

- *energy management systems*: installed advanced control devices and atomic clocks to optimise lighting schedules and minimise energy waste;

- *savings guarantee*: committed to meeting predefined energy reduction targets, which were essential for project financing.

Results: The bundled approach enabled smaller municipalities to overcome barriers such as limited resources and project scale. Key outcomes include: (i) significant reductions in energy consumption and operational costs; (ii) shifting of financial and operational risks to the ESCO, ensuring cost-effectiveness for municipalities; (iii) creation of a replicable model for decentralised and resource-constrained regions.

Challenges addressed: The EPC model helped small municipalities overcome financial and technical barriers, including limited budgets and lack of expertise to undertake energy efficiency projects independently.

Lessons learned: This project demonstrates the effectiveness of EPCs in addressing energy efficiency in decentralised contexts. Bundled procurement strategies can maximise economies of scale, making such initiatives viable for smaller municipalities. The guaranteed savings approach also ensures financial sustainability while minimising risks for municipalities.

3.2.2 Forfeiting

An innovative financing option is forfeiting, which is a **form of transferring future receivables** from one party (the **cessionary** – an ESCO) to another (the **buyer** – a finance institution (FI)). The original creditor (the ESCO) cedes their claims, and the new creditor (the FI) gains the right to claim future receivables from the debtor (the client). The ESCO sells future receivables to an FI in return for a discounted one-time payment. Ceding future receivables is not a stand-alone financing option but can serve as additional collateral for the FI.

Under a forfeiting arrangement, ESCOs structure transactions as extended trade payments and sell the resulting long-term receivables to a bank, which takes on the credit risk.

In a forfeiting transaction, the ESCO or equipment vendor assigns – via an assignment agreement – future receivables (e.g. the end-user payments) from an energy service agreement to a lender together with a pledge of assets. The end user pays the bank directly; the payments are used to amortise the ESCO debt. If an ESCO is involved, the end user, the ESCO and the lender also sign a 'notice and acknowledgement of assignment' where the end user acknowledges the terms of the assignment agreement and further agrees not to set-off any future claims. Under an energy services agreement the ESCO provides a performance guarantee, while the end user pays a fixed monthly payment to amortise the investment. All the technology installed is pledged to the ESCO. The ESCO maintains the system and the end user pays a fixed monthly payment for this service under a separate maintenance agreement (Bertoldi and Rezessy 2010).

3.2.3 Risk-sharing tools and guarantees

3.2.3.1 Risk transfer and risk-sharing tools

Debt financing for EE projects will almost always require some form of guarantee mechanism. In some rare cases the project developer – i.e. a large and well-established ESCO or a large end user – as a company may have a sufficiently strong balance sheet (supported by equity) and strong income statements from other business activities that can be used against the loan. Even in this case end users may prefer to tie their balance sheets with financing core business activities only.

International risk management obligations require commercial banks and leasing companies to demand assets as collateral for loans that are often not available to sustainable energy ventures.

Factoring is a similar form of ceding a bundle of receivables of goods and service deliveries with a short-term payment target and/or ceding single invoices. Factoring mainly transfers the collection of payments and, in the case of non-recourse, also of financial risks to a specialised FI. Factoring is not applicable for long-term contract durations.

This is why guarantee programmes – or any form of publicly backed guarantees – are crucial to ensure that end users and ESCOs are able to access affordable debt financing.

Risks are an inherent feature of financial transactions; thus guarantees can be applied in all phases of the finance continuum to improve access to and the terms of financial products that would be under-supplied without guarantees. The product in need of guarantee can be risk capital (equity or mezzanine finance, bank credits, bonds or security issues or letters of credit). Guarantees for bank credits are the most common form related to EE financing.

Development finance institutions (DFIs) can assume risk and mobilise substantial public or donor funds. Because EE projects are usually too small for DFIs to finance directly, DFIs can support local corporate financing institutions (CFIs) to provide EE financing via the provision of tools such as:

- credit lines for on-lending to EE projects;
- mezzanine debt facilities;
- guarantees and risk-sharing facility programmes;
- support for technical assistance.

DFIs can be multilateral banks (e.g. the World Bank, the International Finance Corporation, the European Bank for Reconstruction and Development (EBRD), etc.) or national development banks (public banks, such as Germany's KfW[22]) or even regional. development banks.

3.2.3.2 Solutions provided by guarantees

Risk-sharing mechanisms – such as partial-risk guarantees – provide collateral from external partners for part of the debt of projects. Partial-risk guarantees can boast EE financing when domestic financial systems do not face liquidity constraints, but financial intermediaries are reluctant to lend to EE projects because of perceived high risks.

Guarantees can help bridge the gap between the perceived credit risks, as reflected in credit underwriting practices, and actual credit risks, thus assisting beneficiaries by providing them with access to finance, reducing their cost of capital, and expanding loan tenor or grace periods to match project cash flows. In this way guarantees can address the credit risk barrier common in many EE market segments and make local FIs more comfortable with the risk.

Partial-risk loan guarantee programmes have shown some success in recent years in jumpstarting EE financing programmes through local FIs (see the IFC's commercial energy efficiency finance programme). They can act to extend the loan repayment period and decrease the interest level, thus improving projects' cash flow and viability. They can also increase debt-to-equity ratios, enhancing returns to developers.

Publicly backed guarantees and insurance schemes can use risk mitigation to steer the flow of private funds towards EE projects, thus leveraging private financing at times of squeezed budgets across the EU. Publicly backed guarantee schemes have been used in project finance and asset finance.

In project finance, publicly backed guarantees can support the implementation of large-scale projects with above-average project risks, accelerate investment in infrastructure, and solve specific debt and equity finance problems in small-scale project finance.

[22] https://www.kfw.de/About-KfW/

In asset finance, publicly backed guarantees enable aggregation and standardisation of small-scale EE loans to end users, as well as the financing of EE investments by ESCOs and low-income households. In asset finance, guarantees can help bring down banks' transaction costs when processing mass requests for end-user finance.

Portfolio guarantees can assume part of the ESCO's financial risk related to revenue streams. Because ESCOs or other energy service providers rely strongly on debt financing, they need precisely budgeted and timed revenue money flows to service their debt. Delays or defaults in payments on the side of their clients may have serious impacts on the servicing of debts of the ESCO itself. Yet, guarantee funds cannot be used as a stand-alone solution and are not appropriate for all market situations. For instance, they are of no or limited use where the main financing challenge is bank liquidity. In markets where financial institutions have sufficient liquidity but low appetite for risk, guarantees should be examined as a mechanism within a larger programme (Bertoldi and Rezessy 2010).

Partial credit guarantee schemes are not an effective instrument for attracting a CFI loan to a project, when the investors' equity is insufficient to comply with the minimum equity requirement for eligibility. In this case, a complementary instrument is needed, such as subordinated debt or equity, which can substitute for and reduce the amount of senior debt and close an existing equity gap. To mobilise EE investment where there is a lack of EE lending experience and limited FI knowledge of EE, there is a need for not only support via credit enhancement financial products, but also technical assistance for financial product development and marketing and for aggregating the market (project pipeline) (Bertoldi and Rezessy 2010).

3.2.3.3 Solutions provided by other debt financing instruments

Funding for municipal energy efficiency via municipal bonds can be arranged by municipalities of bigger cities with the potential to attract the attention of investors. Issuing municipal bonds requires lengthy and expensive preparatory work, consisting of analysing and forecasting the municipality's financial resources and launching a procedure for obtaining a credit rating from an international credit agency. The municipality also needs to define bond emission parameters and prepare an investment memorandum.

The downside to bond financing for municipal energy efficiency is that the benefits from the project accrue over time, usually five to ten years, whereas the principal on the bonds has to be repaid at maturity. This can create cash-flow issues for municipalities if the bonds' maturity date is not linked to the financial savings from the energy efficiency project. Bond financing is beneficial when the revenue from bond issuance is eligible for tax breaks or tax exemptions.

Forfeiting is a suitable opportunity for immediate cash flow for financing an EE project.

The development of forfeiting can be advantageous if the cash flow can serve as main collateral. A pre-condition for forfeiting is the legal rightfulness of the receivables, e.g. the ESCO has to perform the energy performance contract and deliver the savings guaranteed. Generally, the ceded receivables must be from investment, goods or service deliveries with a mid-term duration of six months to five years or longer, which is applicable to future receivables. Forfeiting is expected to be economically advantageous if the client's creditworthiness is better than that of the ESCO or if the project cash flow could serve as main collateral. From the ESCO's perspective, it is desirable that the FI assumes certain risks, such as the client's financial performance risk. In this context non-recourse means that the FI waives the right to resort back to the ESCO, provided that the ESCO has fulfilled the contractual obligation including the EPC's savings guarantee. The transaction costs of setting a forfeiting contract – not a standard financing product to date – may be high (Bertoldi and Rezessy 2010).

3.2.4 Energy-efficient mortgages

An energy mortgage is a mortgage that credits a home's energy efficiency in the home loan. For an energy-efficient home, for example, it could mean giving the home buyer the ability to buy a higher quality home because of the lower monthly costs of heating and cooling the home. For homes requiring improvements, the concept allows the money saved in monthly utility bills to be used to finance energy improvements. There are two types of energy mortgages:

- **energy improvement mortgage** (EIM) - finances the energy upgrades of an existing home in the mortgage loan using monthly energy savings;
- **energy-efficient mortgage** (EEM) - uses the energy savings from a new energy-efficient home to increase the home-buying power of consumers and capitalises the energy savings in the appraisal.

An EEM is a reduced-rate mortgage that credits the energy efficiency of the building in the mortgage itself. To obtain an EEM, a borrower typically has to have an energy rating assessment performed before financing is approved. This verifies to the lender that the building is energy-efficient. In the United States (US), EEMs are typically used to purchase a new home that is already energy-efficient, such as one that is 'Energy Star qualified'

An EIM is used to purchase existing homes that will have an energy efficiency improvement made to them. EIMs allow borrowers to include the cost of energy efficiency improvement in the mortgage without increasing the down payment. EIMs also allow borrowers to use the money saved in utility bills to finance energy improvements. In the US, both EEMs and EIMs require a home energy rating assessment (building certification) to be carried out, to provide the lender with the estimated monthly energy savings and the value of the energy efficiency measures.

In Europe, **private banks** have increasingly issued green mortgage products under initiatives such as the **energy-efficient mortgages action plan** (EeMAP), coordinated by the **European Mortgage Federation - European Covered Bond Council** (EMF-ECBC). Several national schemes have emerged as well, offering preferential mortgage rates for certified energy-efficient buildings or renovation projects. These market-driven instruments complement public financing tools and help scale private investment in building decarbonisation. **France's 'éco prêt à taux zéro'** (éco-PTZ) is a notable example of a public EIM, offering interest-free loans for residential retrofits (see Box 12 for details).

Box 12. Eco-mortgage in France – L'éco prêt à taux zéro (éco-PTZ)

Location: France

Year: Introduced in 2009

Type of financial mechanism: Energy improvement mortgage (EIM)

Objective: To finance energy conservation works in existing residential properties to enhance energy efficiency and reduce environmental impact.

Programme description: France's eco-mortgage programme, known as l'éco prêt à taux zéro (éco-PTZ), was launched in 2009 to support energy efficiency upgrades in homes. The programme allows homeowners to borrow up to EUR 30 000 interest free to finance energy conservation work. Eligible properties must have been constructed between 1948 and 1990.

Key features of the programme include: (i) a maximum loan amount of EUR 30 000, with a cap of EUR 300 per square metre; (ii) a repayment period of 10 years, extendable to 15 years in certain cases; (iii) no resource test or income limit, making the loans accessible to a wide range of homeowners.

Eligible energy efficiency improvements include: (i) wall insulation; (ii) installation of double or secondary glazing; (iii) replacement of entrance doors with energy-efficient alternatives; (iv) upgrades to space and water heating systems to improve energy performance.

To qualify for the loan, the proposed work must meet minimum performance standards, as outlined in the regulations. The eco-mortgage can also be used alongside tax credits for home energy conservation, further incentivising homeowners to adopt sustainable practices. The loans are available through major French banks, ensuring broad access to this financial mechanism.

Results: Since its introduction, the éco-PTZ programme has enabled numerous households to improve the energy efficiency of their homes, contributing to national climate goals by reducing energy consumption and greenhouse gas emissions.

Challenges addressed: (i) Limited access to upfront capital for energy improvements; (ii) encouraging energy retrofits in older buildings, which are less efficient and more costly to upgrade.

Lessons learned: The éco-PTZ programme demonstrates the potential of energy improvement mortgages to drive large-scale adoption of energy-efficient upgrades. By eliminating interest payments and providing accessible financing, the programme highlights how targeted financial mechanisms can overcome economic barriers and support national climate objectives.

3.2.5 On-bill financing

On-bill financing is a mechanism where utility companies **integrate loan payments** for energy efficiency investments directly **into their customers' energy bills**. This approach makes use of the existing relationship between utility companies and their customers to facilitate access to funding for sustainable energy upgrades. By allowing utility companies to potentially disconnect energy supply in the event of default, this model can lower collection costs and improve the credit quality of the financing scheme, which in turn reduces financing costs. Payments tied to utility bills inherently carry a lower risk of credit default, minimising collection risks for the lender.

However, this model is not without challenges. Energy regulators often resist the inclusion of loan repayments in utility bills, citing concerns over complicating the contractual relationship between the utility company and the customer. In particular, they may oppose disconnection provisions tied to loan defaults, as this could conflict with regulatory principles of fairness and simplicity in billing practices.

Despite these challenges, on-bill financing offers a practical way of spreading the costs of energy efficiency investments over time while maintaining affordability and simplicity for end users. Utility companies collect repayments alongside regular energy charges, enabling the customer to finance projects like energy-efficient lighting or heating, ventilation and air conditioning systems without requiring upfront capital (Bertoldi and Rezessy 2010).

A comparable model is **property assessed clean energy** (PACE) financing, where loans for energy upgrades are repaid through local property tax bills rather than utility bills. While more common in the US, PACE-style mechanisms have been piloted and adapted in Europe, particularly in the commercial and municipal sectors. In **Spain**, for example, the city of **Vitoria-Gasteiz** is implementing a large-scale urban renovation plan supported by EU funding, aimed at retrofitting around 15 000

residential units [23]. The project explores integrated financial models combining on-tax and utility-based repayments to facilitate energy upgrades in older buildings. These mechanisms are embedded in the city's broader energy transition strategy and linked to the Spanish recovery and resilience plan, which promotes localised, accessible financing solutions for sustainable renovation.

Box 13. On-Bill financing by Pacific Gas and Electric (PG&E) (Stelmakh and Novikova 2017)

Location: Northern California, US

Year: Ongoing

Type of financial mechanism: On-bill financing with zero interest loans

Objective: To support energy efficiency projects for public institutions by providing accessible financing integrated into utility bills.

Programme description: Pacific Gas and Electric (PG&E) offers a zero interest on-bill financing programme for public institutions to fund energy efficiency projects. Loans range from approximately EUR 4 650 to EUR 232 500 and are repaid through monthly utility bills, with repayment amounts calculated on the basis of projected energy savings. This approach simplifies the financing process, enabling participants to implement upgrades without incurring additional financial burdens.

A critical eligibility criterion for the programme is that the anticipated energy savings must fully cover the loan repayment within the designated payback period. This ensures that participants reduce energy consumption without exceeding their usual utility costs. Typical projects include the replacement or upgrade of municipally-owned street lighting with energy-efficient LED systems.

Results: By 2016, PG&E's on-bill financing programme had supported several hundred projects, replacing or upgrading approximately 180 000 municipally-owned streetlights. The initiative delivered significant energy savings while streamlining the financing process for public institutions.

Challenges addressed: (i) Limited access to upfront capital for energy efficiency projects; (ii) complexity of financing processes for public institutions.

Lessons learned: PG&E's programme demonstrates the effectiveness of on-bill financing in enabling large-scale sustainable infrastructure upgrades. By integrating loan repayments into utility bills and tying them to energy savings, the programme ensures accessibility, scalability, and long-term viability for public institutions seeking to improve energy efficiency.

3.3 Mixed financing

3.3.1 Public-private partnerships (PPPs)

Collaborations between public institutions and private-sector entities can mobilise additional resources and expertise. In such arrangements, private partners may finance, build or operate **EE projects** in exchange for a share of the savings or revenues generated.

[23] https://cadenaser.com/euskadi/2025/04/08/vitoria-busca-financiacion-para-rehabilitar-15000-viviendas-en-los-barrios-de-la-ciudad-ser-vitoria/ (in Spanish).

Cooperation between the municipality, local investors and local citizens is deemed to be a vital factor for successfully achieving the transition to 100% renewable-energy systems (Young and Brans 2017). Municipal leadership usually has a crucial role to play in forging partnerships and pooling resources across the public and private sectors. As an enabler, municipalities have the capacity to steer policies in support of niche innovations that are new to the market and technologies that offer multiple social benefits, including through the establishment of PPPs for local energy generation.

Examples include PPPs for anaerobic digestion of biowaste for combined heat and power (CHP) based district heating and the co-financing of public energy upgrading between local and regional authorities and private investors., The supply of urban biowaste, especially in the **bioenergy sector,** can depend on people's awareness and motivation to put aside organic waste for separate collection. For this reason, it is also important to motivate individuals to participate in waste management strategies so that organic waste can be used to produce biogas. In this case, the municipality uses a concession scheme under certain obligations. For instance, the public authorities promote the construction of a zero emission swimming pool, or a district heating and cooling installation, by allowing a private company to run it, revolving the profits on the initial investment. This kind of contract should be flexible to allow the private company to extend the contract in the event of unexpected payback delays. Frequent due diligence is also recommended to account for fluctuations in revenue streams relevant to the project (e.g. user fees, energy savings, or service-based payments), which can affect the payback period (Hodge and Greve 2007).

PPPs and innovative financing approaches have proven instrumental in the development of bioenergy systems across Europe [24], showcasing their versatility in addressing local energy needs and advancing climate goals. In **Enköping, Sweden**, a PPP facilitated the development of a CHP plant using wood chips as feedstock. Initially supported by significant government subsidies (covering 40% of costs), the project expanded through collaboration with private energy companies and a forestry association. Local willow plantations were introduced to ensure a sustainable supply chain, reducing transportation costs and emissions. The integration of wastewater and sludge recycling further improved the plant's efficiency, showcasing the potential of PPPs to drive innovation while addressing local energy needs. In **Italy**, bioenergy projects have used agricultural residues, such as vineyard prunings, as a consistent feedstock for biomass boilers. Through formalised contracts with local farmers, these initiatives have ensured reliable supply chains while supporting rural economies. A biogas project in Este, Italy, uses organic waste for district heating and plans to expand capacity by 4.5 MW, integrating district cooling systems funded by the European local energy assistance (ELENA) programme. These projects exemplify how PPPs can reduce emissions (by 30% in Este's case) and create local economic benefits. In **Greece**, a decentralised biomass system uses agricultural residues like prunings, straw and other waste from crops including grapes, rice and olives. Distributed across 200 hectares, this system produces substantial heat and electricity (2 784 060 GJ and 618 680 GJ, respectively), demonstrating how PPPs can integrate diverse feedstocks to address energy and waste management challenges. In **Spain**, the Landia biogas plant highlights how innovative technologies such as the organic Rankine cycle optimise electricity production. This plant, which has been operational since 2012, processes manure and maize silage, ensuring financial viability through a feed-in tariff while reducing biogas and feedstock demand. This showcases the adaptability of PPPs to align with regulatory and market frameworks. **Denmark's** biogas and heat markets are among the most advanced in Europe, with

[24] http://www.biogasheat.org/.

biogas used for district heating and industrial processes. Recent initiatives have focused on injecting upgraded biogas into the natural gas grid and supporting green transport solutions. These advancements – driven by government efforts to scale production tenfold – underline the importance of PPPs in fostering innovation and addressing future energy challenges.

Integrating green criteria into PPPs has emerged as a critical strategy for ensuring that these collaborations are in line with climate goals. By embedding sustainability performance indicators and environmental benchmarks into project frameworks, PPPs can contribute significantly to climate adaptation and mitigation efforts. Such criteria may include requirements for energy efficiency, renewable-energy integration, sustainable materials, and resilience to climate impacts (Amin 2023).

Including green metrics in PPPs ensures that projects not only meet immediate public needs but also align with long-term climate objectives. For example:

- energy efficiency: PPPs can require the use of energy-efficient technologies in public buildings and infrastructure, reducing long-term operational costs and emissions;
- renewable-energy integration: projects can be structured to prioritise the use of renewable energy sources, such as solar or wind, in energy supply contracts;
- climate resilience: infrastructure projects can incorporate design features that improve resilience to climate risks, such as flooding or heatwaves.

For instance, **Tunisia's communal loan fund** (CPSCL) integrates green criteria into its financial support for municipalities. Through a PPP framework, the fund finances projects in renewable energy, sustainable waste management, and water resource management. This approach not only ensures the sustainability of funded projects but also builds local capacity for managing green infrastructure (Amin 2023).

Benefits of green PPPs include:

- enhanced climate impact: by prioritising green criteria, PPPs ensure that private investments help achieve national and international climate goals;
- risk mitigation: incorporating resilience measures reduces vulnerabilities to climate-related risks, safeguarding public and private investments;
- financial viability: green criteria can attract additional funding from international climate finance mechanisms and environmentally focused investors.

The **Zorrotzaurre** project in Bilbao, Spain showcases a successful PPP aimed at transforming an industrial and polluted peninsula into a residential island to mitigate flood risks. This initiative managed to reduce potential damages by between 31% and 100%, depending on the severity of the flood. Key success factors include risk-sharing through public financial commitments to attract private investors, a management board with defined roles for shareholders to enhance trust and efficiency, and the involvement of the local community through public consultations to increase project

acceptability. The project, costing over EUR 21 million, involves both public authorities and private companies, with a shareholding structure of 51% public and 49% private [25].

Box 14. PPPs and citizen financing in Copenhagen (Ulpiani et al. 2023)

Location: Copenhagen, Denmark

Year: Ongoing since the 2010s, with a focus on the city's 2025 climate neutrality target.

Type of financial mechanism: PPPs and citizen-driven financing schemes, including crowdfunding (for additional info on crowdfunding see Section 4.1.1).

Objective: To accelerate climate action by using private investment and community engagement for renewable energy and sustainable infrastructure projects.

Programme description: Copenhagen has adopted a dual financing approach to support its climate goals:

- *PPPs.* The city collaborates with private investors to fund large-scale renewable energy projects, such as wind farms and district heating systems. These partnerships combine public and private resources to deliver impactful, climate-aligned initiatives.

- *Citizen financing.* Through crowdfunding and similar schemes, residents can directly invest in local solar and wind energy projects. This fosters community ownership, increases engagement and secures additional funding for the city's sustainability agenda.

Results: (i) Development of significant renewable energy infrastructure, contributing to Copenhagen's progress towards climate neutrality by 2025; (ii) increased community involvement and support for the city's climate initiatives; (iii) enhanced collaboration between public institutions, private investors, and citizens, creating a robust financing model.

Challenges addressed: (i) Engaging diverse stakeholders, including private-sector entities and citizens, in financing and decision-making; (ii) ensuring long-term financial viability and public trust in innovative financing schemes.

Lessons learned: (i) Combining PPPs with citizen financing creates a comprehensive model for climate action funding; (ii) citizen participation fosters greater public support and aligns financial strategies with community interests; (iii) inclusive and innovative financial approaches can serve as replicable models for other cities aiming for ambitious climate goals.

Box 15. Innovative district heating with heat pumps in Braedstrup [26], Denmark

Location: Braedstrup, Denmark

Year: Ongoing since the 2010s

Type of financial mechanism: Public-Private Partnership (PPP)

Objective: To develop a sustainable district heating system integrating solar thermal energy, seasonal thermal energy storage and large heat pumps, thereby reducing reliance on fossil fuels and enhancing energy efficiency.

[25] https://climate-adapt.eea.europa.eu/en/metadata/case-studies/public-private-partnership-for-a-new-flood-proof-district-in-bilbao

[26] https://r-aces.eu/use_case/braedstrup-district-heating/.

Programme description: The Braedstrup district heating project exemplifies an innovative PPP model where municipalities collaborated with private partners to implement a comprehensive renewable heating solution. The system combines: (i) a large solar thermal collector field (10 600 m^2); (ii) seasonal thermal energy storage (19 000 m^3 borehole storage); (iii) a 1.5 MW heat pump to elevate temperatures for district heating. This integration allows excess solar heat collected during summer months to be stored and used during colder periods, with the heat pump ensuring the delivery of heat at suitable temperatures for residential and commercial use.

Results: (i) The system supplies approximately 20% of Braedstrup's annual heating demand; (ii) plans are underway to expand the solar collector area to 50 000 m^2, to cover up to 50% of the community's heating needs; (iii) the project demonstrates the viability of combining multiple renewable technologies within a PPP framework to achieve significant reductions in carbon emissions and energy costs.

Challenges addressed: (i) Reducing dependency on fossil fuels for heating; (ii) managing seasonal variations in energy supply and demand; (iii) ensuring financial viability and stakeholder collaboration in renewable energy projects.

Lessons learned: (i) PPP models can effectively mobilise resources and expertise for complex renewable energy projects; (ii) integrating various renewable technologies improves system flexibility and reliability; (iii) community engagement and transparent governance are critical for the success of such initiatives.

3.3.2 Green bonds

Green bonds are **debt instruments** specifically issued to finance **environmental and climate-related projects**. They allow municipalities to attract private investors interested in supporting sustainable development. By attracting private investors, these bonds provide municipalities with upfront capital to finance large-scale projects that generate long-term cost savings or other revenue streams.

Green bonds – increasingly used by local governments – are pivotal in financing actions under SECAPs. These instruments help municipalities fund initiatives targeting energy efficiency, renewable energy, sustainable transportation and climate adaptation. By aligning financial resources with SECAP objectives, green bonds support broader environmental goals, such as those outlined in the European Green Deal.

The **advantages** of green bonds for municipalities include:

- **targeted funding**: green bonds directly support key projects, such as retrofitting public buildings, deploying renewable energy systems and upgrading infrastructure to mitigate climate change impacts;
- **enhanced financial flexibility**: these bonds enable municipalities to undertake large-scale initiatives without significantly straining their budgets, making them a viable solution for achieving both short-term project goals and long-term fiscal health;
- **commitment to sustainability**: issuing green bonds signals a municipality's dedication to achieving climate neutrality, aligning local actions with EU policies and attracting sustainable investors, thereby strengthening its reputation as a climate leader.

Many cities across Europe have used green bonds effectively to finance climate-related measures, showcasing their versatility and impact in driving sustainability initiatives.

In **Gothenburg**, **Sweden**, green bonds have been issued since 2013 to support various projects, including energy-efficient street lighting, biogas production, sustainable urban transport systems,

district heating, and the adoption of electric vehicles. This pioneering approach has established the city as a leader in green financing [27]. Sweden has also demonstrated the potential of centralised green-bond frameworks through **Kommuninvest**, a national municipal funding agency. By pooling resources from its 295 member municipalities, Kommuninvest has financed over 600 environmentally impactful projects, ranging from energy efficiency to climate adaptation (further details are explored in Box 14). This model has inspired similar initiatives in Denmark, Finland, and Norway (Commission for the Environment - Climate Change - Energy 2024). In the **province of Barcelona**, **Spain**, green bonds have played a crucial role in financing energy efficiency retrofits in municipal buildings and expanding renewable energy installations, aligning local efforts with broader sustainability goals. Similarly, in **Oslo**, **Norway**, green bonds have been used to advance the city's ambitious climate agenda, funding projects such as the electrification of public transport and the installation of solar panels on public buildings. In **Île-de-France**, **France**, which includes Paris, green bonds have been used to support renewable energy developments, energy-efficient school renovations and urban greening efforts, reinforcing the region's commitment to environmental progress.

Moreover, many cities participating in the **climate-neutral cities mission** have integrated green bonds into broader financing strategies. For example, in **Sweden**, **Spain**, and **Germany**, green bonds are often paired with innovative mechanisms like revolving funds and PPPs. These approaches help overcome initial capital cost barriers while fostering collaboration with private stakeholders. In **Türkiye** and the **Netherlands**, thematic green bonds have successfully attracted investments for projects like sustainable transportation systems and energy efficiency initiatives in urban settings (Ulpiani et al. 2023).

Box 16. Green bonds in Sweden – Kommuninvest green-bond framework (Commission for the Environment - Climate Change - Energy 2024)

Location: Sweden, national level (295 member municipalities)

Year: Green-bond issuance began in 2015

Type of financial mechanism: Green bonds with centralised municipal funding

Objective: To provide financing for local government projects that reduce greenhouse gas emissions, strengthen climate resilience, and support Sweden's goal of achieving net-zero emissions by 2045.

Programme description: Kommuninvest, Sweden's leading municipal funding agency, developed a green-bond framework to raise funds for local government initiatives promoting environmental sustainability. Acting as an aggregator, Kommuninvest pools investments from its 295 member municipalities, enabling even the smallest municipalities to access financing for climate-related projects. This centralised approach simplifies funding processes and ensures broad participation in Sweden's green transition.

Key projects funded include energy-efficient infrastructure, sustainable transport systems and climate adaptation measures. One standout example is a new primary school in Lerum municipality, designed with advanced climate adaptation features:

[27] https://unfccc.int/climate-action/momentum-for-change/financing-for-climate-friendly/gothenburg-green-bonds.

- *Rainwater management systems*: Connecting the site to the Säve River to manage heavy rainfall effectively.

- *Biodiversity enhancements*: Including an amphibian pond and a biodiversity tunnel to preserve local ecosystems and improve environmental resilience.

Results: (i) Over 600 climate-related projects funded since 2015; (ii) small municipalities overcame financial and administrative barriers; (iii) inspired similar centralised green-bond models in Denmark, Norway, and Finland.

Challenges addressed: (i) Limited access to financing for small municipalities; (ii) administrative complexity in securing individual project funding.

Lessons learned: Kommuninvest's green-bond framework showcases the effectiveness of a centralised approach to financing environmental projects. By pooling resources, municipalities can collectively achieve ambitious climate goals, demonstrating the replicability of this model for other regions seeking to scale up their green financing efforts.

Box 17. Green bonds in London – Financing sustainable urban development (Ulpiani et al. 2023)

Location: London, United Kingdom

Year: Initiated in 2015

Type of financial mechanism: Green bonds for sustainable transportation and infrastructure projects

Objective: To finance large-scale energy efficiency and renewable energy projects to advance sustainable urban development and meet London's ambitious climate goals.

Programme description: London has emerged as a leader in green finance to promote sustainable urban development. A significant initiative is the issuance of green bonds by Transport for London (TfL). In 2015, TfL issued its first green bond, raising GBP 400 million to fund a variety of low-carbon transportation projects.

By tapping into the bond market, TfL attracts a diverse range of investors interested in supporting environmental projects. This approach mobilises financial resources and establishes a robust mechanism for scaling up climate action efforts. The funds raised through green bonds have been allocated to:

- *expanding sustainable public transportation*: investment in the London Underground and Overground networks to improve efficiency and reduce emissions.

- *procuring low-emission vehicles*: introduction of electric and hybrid buses to decrease carbon emissions and improve air quality;

- *improving cycling and pedestrian infrastructure*: development of safer and more accessible routes to encourage low-carbon modes of transport.

The innovative use of the bond market demonstrates how local governments can engage private capital to finance critical sustainability projects, ensuring long-term environmental and financial benefits.

Results: The issuance of green bonds in London has successfully mobilised substantial private capital, providing significant funding for sustainable infrastructure projects. These initiatives have contributed directly to reducing carbon emissions and improving air quality in the city, advancing London's ambitious climate goals. Moreover, London has solidified its position as a global leader in green finance, setting a benchmark for other cities looking to leverage green bonds for urban sustainability.

Challenges addressed: London's green-bond programme has effectively tackled key barriers to financing large-scale sustainability projects. By securing upfront capital through the bond market, it has alleviated the financial strain on public budgets, enabling the city to undertake transformative initiatives. The programme

has also successfully engaged a diverse investor base by aligning financial returns with measurable environmental impacts. This approach has not only attracted private capital but has also established a scalable model for funding ongoing and future climate action projects.

Lessons learned: The success of London's green-bond programme underscores the viability of green bonds as a financing mechanism for public sustainability projects. It also highlights the critical role of public-private collaboration in addressing environmental challenges, demonstrating how private investment can support public climate objectives. Lastly, the programme offers a replicable model for other cities, illustrating how green bonds can be adapted to finance large-scale sustainable development efforts and drive meaningful environmental change.

Box 18. Green bonds in Poland: a pioneering model in state-level green financing (Gancheva et al. 2019)

Location: Poland

Year: Initiated in 2016; ongoing.

Type of financial mechanism: Green bonds

Objective: To provide alternative financing for environmentally friendly investments, contributing to Poland's climate goals and aligning with international green finance standards.

Programme description: Poland became the first country in the world to issue state-level green bonds in December 2016. The initiative, coordinated by the Ministry of Finance, identifies eligible projects for green-bond funding based on a rigorous assessment aligned with the green bond framework. Approved projects are funded through proceeds from bond issuance, which are then tracked via dedicated accounts. This system ensures transparency and accountability, with annual reports detailing fund allocation and use.

The bonds target various sectors, including renewable energy, energy efficiency, sustainable transport, water management, and biodiversity protection. Local and regional governments have potential access to similar models, promoting the wider adoption of green financing at sub-national levels.

Results: (i) Successful issuance of multiple rounds of green bonds since 2016; (ii) funds allocated to key environmental projects, including climate adaptation and renewable energy; (iii) high-scoring evaluations from international financial institutions, boosting Poland's reputation in sustainable finance.

Challenges addressed: (i) Securing upfront capital for large-scale sustainable projects; (ii) demonstrating the viability of green bonds in a state-level context, providing a scalable model.

Lessons learned: (i) State-level green bonds offer a replicable framework for other nations and regions; (ii) annual reporting increases transparency, encouraging investor confidence and stakeholder trust.

3.3.2.1 Blue bonds

Blue bonds are an innovative **subcategory of green bonds**, specifically designed to finance projects that protect and restore aquatic and marine ecosystems while promoting the sustainable **management of water resources**. These bonds are particularly relevant in addressing water-related challenges that arise from climate change, offering tailored financial solutions to foster environmental, social, and economic resilience.

In **urban areas**, blue bonds play a vital role in funding **climate adaptation measures** connected to water management, including:

— **flood risk mitigation**: developing infrastructure such as flood barriers and enhanced drainage systems to reduce the impacts of extreme rainfall;

— **wetland preservation**: protecting and restoring wetlands, which act as natural buffers against flooding and provide critical habitats for biodiversity;

— **coastal protection**: implementing measures to safeguard coastal areas from erosion and rising sea levels;

— **rainwater harvesting systems**: installing systems to collect and store rainwater for urban use, reducing strain on existing water supplies;

— **river restoration**: revitalising urban rivers to improve biodiversity, enhance water quality, and reduce flood risks.

The **benefits** of blue bonds are multifaceted. They enhance environmental sustainability by increasing resilience to climate change and protecting critical ecosystems that are essential for biodiversity and natural disaster mitigation. Economically, they provide **cost-effective solutions** for managing water resources and reducing the risks associated with climate-related events, thereby lowering long-term expenses for governments and communities. Socially, they ensure **access to clean water**, protect livelihoods dependent on aquatic ecosystems, and promote community well-being through **sustainable development**.

What makes blue bonds particularly compelling is their ability to **attract private investors** seeking impactful climate actions. These bonds align financial returns with measurable environmental and social outcomes, offering a meaningful way to **contribute to global climate adaptation goals**.

An example of a private-sector initiative using blue bonds is **Ørsted's** USD 100 million (approximately EUR 93 million) blue bond issuance [28]. This **Danish** energy company used the bond to finance offshore renewable energy projects, demonstrating the potential of blue bonds to support large-scale sustainable developments. Ørsted's bond highlights the adaptability of this financial instrument for driving innovation in the energy sector while contributing to the protection of marine ecosystems and advancing climate goals.

3.3.2.2 Climate bonds

Climate bonds, a specialised type of green bond, are financial instruments issued to fund **climate-related projects**. Their primary objective is to mobilise private-sector capital for initiatives that reduce GHG emissions and accelerate the transition to a low-carbon economy. Typical projects funded by climate bonds include **renewable energy installations**, **energy efficiency upgrades**, and **sustainable transportation infrastructure**.

The global market for climate bonds has grown substantially over the past decade, driven by increased awareness of climate change and international commitments such as the Paris Agreement. Issuers of climate bonds range from governments and municipalities to corporations and multilateral development banks, reflecting their widespread applicability across sectors.

According to the **Climate Bonds Initiative** (CBI), climate bonds have mobilised over USD 2 trillion (approximately EUR 1.86 trillion) in capital globally. These funds primarily target renewable energy, low-carbon buildings, and sustainable transportation. The CBI also provides certification standards to

[28] https://www.man.com/maninstitute/blue-bonds-sustainable-debt.

ensure that projects financed through climate bonds meet rigorous environmental criteria, enhancing their credibility and bolstering investor confidence. By aligning financial systems with decarbonisation pathways, climate bonds are instrumental in achieving the targets set under the Paris Agreement [29].

Benefits of climate bonds include:

- targeted financing: funds are earmarked for specific projects with clear climate benefits;
- scalability: climate bonds attract institutional investors, mobilising large-scale capital;
- transparency: they often require robust reporting and monitoring frameworks to ensure accountability.

Climate bonds have emerged as a cornerstone of sustainable finance, aligning financial flows with global climate goals. Their widespread adoption has not only advanced mitigation efforts but has also paved the way for innovative financial instruments to address both climate adaptation and resilience challenges.

3.3.2.3 Climate resilience bonds and environmental impact bonds

Climate resilience bonds are a subset of climate bonds specifically designed to finance projects that **improve resilience to climate risks**. Unlike broader climate bonds, these instruments focus on **adaptation measures**, such as flood defences, drought-resistant infrastructure, and resilient agricultural systems.

The EBRD has been a key player in this space. In 2020, it issued a USD 1.15 billion (approximately EUR 1.07 billion) climate resilience bond, directing funds toward infrastructure upgrades, water resource management, and agricultural systems designed to withstand climate shocks. This bond illustrates the potential of resilience-focused instruments to address both immediate and long-term climate challenges (Global Center on Adaptation (GCA) 2020).

Benefits of climate resilience bonds include:

- adaptation financing: focuses on improving the ability of communities and systems to adapt to changing climatic conditions;
- risk mitigation: reduces the economic impact of climate-related disasters;
- sustainability: promotes investments in long-term infrastructure resilience.

Successful implementation of climate resilience bonds requires a robust assessment of climate risks and a clear framework for measuring resilience outcomes. By addressing these challenges, resilience bonds can play a critical role in supporting both public and private efforts to adapt to climate change.

Environmental impact bonds (EIBs) are innovative financial instruments designed to fund environmental projects by linking investment returns to specific ecological outcomes. While they are more prevalent in the United States, they are gaining traction in Europe, with several cities and countries exploring their potential for funding environmental projects in areas such as water management and urban green infrastructure. EIBs operate similarly to traditional bonds but focus on

[29] https://www.climatebonds.net/.

environmental initiatives, such as green infrastructure, ecosystem restoration, or pollution reduction projects. Key features of EIB s include:

- **Outcome-based returns**: Investors receive returns based on the achievement of predefined environmental outcomes, such as improved water quality or increased carbon sequestration. This aligns financial incentives with environmental performance.
- **Risk sharing**: EIBs often involve sharing the financial risk between investors and project implementers. If the project achieves its environmental goals, investors may receive a return higher than the principal investment; if not, returns may be lower or only the principal may be repaid.
- **Public-private partnerships**: EIBs typically involve collaboration between public entities, such as governments or municipalities, and private investors, leveraging private capital for public environmental benefits.
- **Performance measurement**: Successful implementation of EIBs requires robust systems for measuring and verifying environmental outcomes, ensuring transparency and accountability.

Overall, EIBs represent a promising approach to financing environmental projects by attracting private investment and emphasising accountability for achieving tangible ecological benefits (Trotta 2024).

3.3.3 Social bonds

Social bonds are financial instruments specifically designed to raise funds for projects that address important **social issues**, aiming to generate measurable social outcomes. These bonds focus on supporting initiatives for **vulnerable populations**, such as unemployed individuals, people living below the poverty line, marginalised communities (e.g. migrants, women, sexual and gender minorities), and people with disabilities. Unlike green bonds, which are dedicated to environmental objectives, social bonds target social improvements and aim to meet critical needs that are often underserved by traditional financing.

Social bonds are increasingly used to support projects that promote **long-term social benefits**, such as improving access to affordable housing, education, healthcare, and employment opportunities. For instance, **Cassa Depositi e Prestiti in Italy** has issued social bonds to fund urban development, infrastructure, and public service improvements, directly contributing to better living conditions in underserved areas [30]. Similarly, **Morgan Stanley's** approximately EUR 935 million (USD 1 billion) social bond issued in 2020 supports affordable housing initiatives, benefiting low- and moderate-income families [31].

As the social bond market grows – particularly in Europe and Asia – its ability to tackle pressing social challenges while offering investment returns becomes increasingly evident. These bonds align with the SDGs, particularly those aimed at reducing inequality and improving access to essential services.

[30] https://www.icmagroup.org/assets/documents/Regulatory/Green-Bonds/June-2020/Social-and-sustainability-bond-case-studiesJune-2020-090620.pdf.

[31] https://www.morganstanley.com/assets/pdfs/Morgan_Stanley_2021_Social_Bond_Impact_Report.pdf.

3.3.4 Sustainability bonds

Sustainability bonds are a **hybrid financial instrument** combining the features of both green bonds and social bonds. Unlike green bonds, which are strictly designated for projects with environmental benefits, sustainability bonds allocate the proceeds to **both green and social projects**.

For example, a social project that includes environmental co-benefits, such as building affordable housing with energy-efficient features, can be classified as a sustainability bond. This dual focus allows issuers to finance a **broader range of initiatives** that contribute to both environmental and social goals, such as renewable energy projects combined with social infrastructure like healthcare and education [32].

The popularity of sustainability bonds has been growing due to their **flexibility**. They allow issuers to support a wider **variety of projects**, enabling more diverse funding opportunities and facilitating the alignment of multiple SDGs. This flexibility is particularly beneficial for municipalities and companies looking to make a broader impact across both environmental and social dimensions [33].

3.3.5 Mini-bonds

Mini-bonds are debt instruments issued by unlisted companies, SMEs, or municipalities to raise capital. They are characterised by their smaller size compared to traditional bonds, with typically limited nominal value and shorter maturity periods. Mini-bonds offer a flexible solution for organisations that lack direct access to major financial markets, providing an alternative to traditional bank loans. They can be used to finance a wide range of projects, from operational needs to strategic initiatives, and are gaining popularity as a vehicle for supporting **sustainability** and **climate resilience** efforts.

Mini-bonds are particularly valued for:

- **accessibility:** they allow smaller issuers to access capital markets;
- **flexibility:** they can be structured to meet specific project or market conditions;
- **green potential:** they are often used for projects with positive environmental impacts, such as renewable energy, sustainable waste management, and energy efficiency.

However, they come with challenges such as relatively high issuance costs and the need for specialised expertise in their management. The lack of uniform regulation across Europe can also complicate their adoption and transparency.

In Europe, mini-bonds are increasingly being used as a financing tool. One specific example is the use of mini-bonds in **Lithuania** to support urban solid waste management projects (Bužinskė et al. 2025). Lithuanian municipalities have successfully employed mini-bonds to fund initiatives such as installing advanced waste treatment facilities and upgrading recycling infrastructure. These bonds enable municipalities to address funding gaps left by public grants or EU programmes, providing greater

[32] https://www.icmagroup.org/assets/documents/Regulatory/Green-Bonds/June-2020/Social-and-sustainability-bond-case-studiesJune-2020-090620.pdf.

[33] https://gca.org/wp-content/uploads/2021/10/Green-Bonds-for-Climate-Resilience_State-of-Play-and-Roadmap-to-Scale.pdf.

financial flexibility and autonomy. The Lithuanian example illustrates how mini-bonds can effectively drive local sustainability initiatives, demonstrating their potential to be integrated into comprehensive financing schemes to support the transition to a circular economy.

3.3.6 Green loans and municipal framework loans

Green loans are an innovative financial instrument designed to support **sustainable environmental projects**. They are typically characterised by a **combination of public funding and private-sector** involvement. Unlike traditional loans, green loans offer preferential terms, such as reduced or zero interest rates, aimed at making environmentally beneficial investments more accessible. Their hybrid structure harnesses public funds to reduce risks and costs for private investors while aligning with environmental and climate goals [34].

Green loans are increasingly being used to finance energy efficiency projects, renewable energy installations, and sustainable infrastructure development. Their design makes them suitable for municipalities, companies, and households that might otherwise struggle to access commercial loans for green projects.

However, vulnerable groups, such as low-income households, typically rely more on grants than on loans, including green loans, due to higher financial barriers and limited repayment capacity. In these contexts, green loans can play a complementary role when paired with subsidies or guarantees that ensure affordability.

Benefits of green loans include:

- **accessibility:** reduced financial barriers enable a wider range of stakeholders, including municipalities, companies, and individuals, to invest in sustainable projects;
- **risk reduction:** public guarantees or subsidies associated with green loans lower the perceived risks for private investors;
- **scalability:** green loans mobilise additional financing from private and institutional investors, scaling up the impact of sustainability initiatives.

Box 19. Green loans in Brussels (Economidou and Bertoldi 2014)

Location: Brussels, Belgium

Year: Since 2008 (initially launched as the 'social green loan')

Type of financial mechanism: Subsidised loans (0%-2% interest), supported by public funding

Objective: To facilitate the adoption of energy efficiency measures by households and businesses, with a specific focus on low-income groups, addressing energy poverty while promoting environmental and social sustainability.

Programme description: The programme provides zero or low-interest loans for energy renovation projects, including building insulation, installation of efficient heating systems, and renewable energy technologies (e.g. solar panels). Loan conditions are tailored to household income, ensuring accessibility for low-income

[34] https://www.worldbank.org/en/news/feature/2021/10/04/what-you-need-to-know-about-green-loans.

families. The initiative is managed by financial cooperatives and the Housing Fund of the Brussels-Capital region.

Results: (i) Improved access to financing for green renovation projects; (ii) reduction of energy poverty through targeted support for vulnerable households; (iii) increased adoption of energy-efficient and renewable technologies.

Challenges addressed: (i) Expanding reach among economically disadvantaged groups; (ii) ensuring effective management and comprehensive support throughout the renovation process.

Lessons learned: (i) Subsidised loans are an effective tool for driving energy efficiency adoption; (ii) the involvement of financial cooperatives and housing funds is key to delivering inclusive and targeted programmes; (iii) integrating environmental and social objectives amplifies the programme's overall impact.

Urban framework loans or municipal multi-component (framework) loans are provided by institutions like the EIB to support cities and regions with diverse financing needs [35]. For large investment projects exceeding EUR 25 million, EIB provides dedicated investment loans that cover up to half of the total cost, although typically around one third. These loans are crucial in attracting additional investors.

Framework loans, on the other hand, finance multiple projects on infrastructure, energy efficiency, and urban renovation, for example, grouped into multiannual investment programmes. These loans are flexible, but must align with the EIB's objective of ensuring that projects are economically, financially, technically, and environmentally viable. Interest rates can vary, with options for fixed, floating, or convertible rates. EIB may charge fees for various services, and loans are primarily in euro but available in other currencies. Repayment is usually semi-annual or annual, with possible grace periods during the construction phase.

Recent examples include the EIB's framework loan to the City of **Florence, Italy,** to support its urban development and climate strategies –including investments in river restoration, bio-diverse water retention basins, sustainable drainage solutions, and sustainable mobility. EIB also financed **Krakow, Poland's** city adaptation plan, which includes sustainable mobility, green spaces and public buildings such as schools and hospitals, and that of **Kielce, Poland**, financing roads, social facilities, sustainable mobility, and green spaces. For the latter, co-financing was provided under the Solidarity Package for Ukraine to meet the increased service demands from Ukrainian refugees [36].

3.3.7 Pay-for-performance models and payments for ecosystem services

Pay-for-performance (P4P) models are financing mechanisms where **payments are directly linked to the achievement of specific and measurable outcomes**. This model is designed to incentivise the successful implementation of sustainable energy measures by aligning the financial rewards with the performance results. For example, payments might be tied to energy savings or emissions reductions that are verified after a project is completed.

[35] https://eu-mayors.ec.europa.eu/en/node/43

[36] https://www.eib.org/en/projects/all/20220014

These models are increasingly being used in sectors such as **EE, renewable energy projects, and climate adaptation**. By ensuring that financial disbursements are made on the basis of actual, verified outcomes, P4P contracts reduce the risk for investors and ensure that funds are used effectively. This approach is particularly attractive to governments and private investors alike, as it shifts the financial risk away from the investor and places it on the service provider or project implementer, who only gets paid upon achieving the desired results.

For instance, in the context of EE retrofits in buildings, a P4P model might reward the contractor based on the actual energy savings achieved by the retrofit, verified through post-installation energy audits. This ensures that the contractor has a direct incentive to deliver the highest possible savings, benefiting both the client and the broader climate goals. Similarly, in emission reduction projects, payments can be tied to the measured reduction in carbon dioxide emissions, ensuring that the investment leads to tangible climate benefits.

P4P models are growing in popularity due to their **ability to deliver verifiable results**, **create accountability**, and **ensure cost-effectiveness in achieving sustainability goals**. They also help **optimise the use of public funds** by ensuring that investments are only made when positive outcomes are achieved.

The main **benefits** are summarised below.

- **outcome-focused:** payments are directly tied to the achievement of specific SECAP targets, ensuring that financial disbursements are made only when the desired outcomes, such as energy savings or emissions reductions, are met.
- **risk sharing:** this model places the responsibility for underperformance on the contractors or service providers, who only receive payment if they meet the agreed-upon performance criteria. This reduces financial risk for governments or investors.
- **encourages innovation:** by linking financial rewards to tangible results, providers are incentivised to implement the most effective and innovative solutions to achieve the outcomes, driving efficiency and cost-effectiveness in the process.

Box 20. The energy savings meter programme (Tzani et al. 2022)

Location: Germany

Year: Launched in 2016

Type of financial mechanism: Pay-for-performance (P4P) model for energy efficiency

Objective: To promote the adoption of digital technologies that improve energy efficiency across various sectors.

Programme description: The energy savings meter programme, initiated by the German Federal Ministry for Economic Affairs and Energy, incentivises energy savings through digital solutions. Under this model, businesses receive funding based on the actual energy savings achieved by their customers. These savings are measured and verified using advanced digital tools, such as smart meters and energy management systems. The programme supports diverse projects, ranging from offices and retail spaces to industrial sites and public facilities like hospitals and swimming pools. This innovative approach ensures that financial rewards are tied directly to verified performance outcomes.

Results: (i) Improved energy efficiency across various sectors, contributing to Germany's broader climate goals; (ii) adoption of advanced digital technologies for monitoring and managing energy use; (iii) increased engagement from businesses in offering efficiency solutions to clients.

Challenges addressed: (i) Encouraging the deployment of digital infrastructure to enable accurate measurement of energy savings; (ii) aligning financial incentives with verifiable outcomes to ensure cost-effectiveness.

Lessons learned: (i) Digital solutions play a critical role in enabling pay-for-performance models; (ii) the integration of advanced measurement tools ensures transparency and accountability in energy efficiency projects; (iii) public funding tied to measurable outcomes can effectively drive innovation and sustainability in the private sector.

Payments for ecosystem services (PES) are voluntary mechanisms that finance environmental protection through agreements between beneficiaries and providers of environmental services, such as carbon sequestration, water purification, biodiversity preservation, and soil fertility enhancement. For example, in the **Emilia-Romagna region, Italy**, a portion of water tariff income is allocated to safeguard groundwater recharge areas. This regional regulation supports sustainable forest management and stream maintenance, providing additional benefits such as carbon absorption and biodiversity preservation. In addition, in the **Po Delta Park**, PES operate through mechanisms such as regulated hunting and mushroom picking permits, traditional fishing management, and eco-tourism initiatives. Revenues from these activities are reinvested in conservation efforts, thereby integrating financial goals with ecological preservation and climate adaptation (Gaglio et al. 2023).

3.3.8 Blended finance

Blended finance refers to the **strategic use of public or philanthropic funds to mobilise private-sector** investment for sustainable development projects. By reducing risks or increasing returns for private investors, blended finance makes it possible to fund initiatives that might otherwise struggle to secure financing. This approach is particularly useful in sectors with high risks or long-term returns, such as **climate change adaptation, renewable energy, and urban infrastructure**.

Blended finance offers several **advantages**:

- **risk mitigation:** public funds often absorb the highest-risk portion of the investment, encouraging private investors to participate by reducing their financial exposure;
- **scalability:** by pooling public and private capital, blended finance enables large amounts of funding to be mobilised for large-scale projects, such as national renewable energy programmes or urban climate resilience initiatives;
- **flexibility:** this financing model can be adapted to various project sizes, from small community-based projects to large-scale infrastructure developments, allowing it to meet diverse needs.

Box 21. Blended finance in Slovakia: LIFE living rivers project (Commission for the Environment - Climate Change - Energy 2024)

Location: Slovakia (Danube, Hron, Ipeľ, and Belá river basins)

Year: Ongoing

Type of financial mechanism: Blended finance, combining EU grants, national funds, and private-sector contributions

Objective: To restore 350 km of rivers, boosting climate resilience, water retention, biodiversity, and flood risk management.

Programme description: The LIFE living rivers project employs a multi-layered financing model to support large-scale river restoration efforts. The total budget of EUR 27.8 million is funded by a mix of sources: 60% (EUR 16.7 million) comes from EU grants, with the remainder provided by national funds and private contributions. Additional financing of EUR 86 million has been mobilised from complementary sources such as Slovakia's recovery and resilience plan and the operational programme quality of environment. This collaborative approach brings together public, private, and academic stakeholders, including the Research Institute of Water Management, WWF Slovakia, and Czech universities.

Results: (i) Restoration of river ecosystems to improve biodiversity and climate resilience; (ii) mobilisation of significant additional funding through complementary financing mechanisms; (iii) strengthened collaboration between public, private, and academic sectors.

Challenges addressed: (i) Managing the complexity of multi-source financing; (ii) coordinating between diverse stakeholders to ensure project alignment.

Lessons learned: (i) Blended finance effectively mobilises capital for large-scale climate adaptation projects; (ii) public grants combined with private contributions can mitigate risks and enhance scalability; (iii) cross-sector collaboration is crucial for long-term project sustainability and success.

Blended finance is essential for bridging the funding gap for **nature-based solutions** and biodiversity restoration. It combines public and private funds in order to maximise return on investment and to mitigate risks. Public funds currently account for 86% of nature-based financing, with private finance accounting for the remaining 14% [37].

To meet global biodiversity and climate targets, investments in these areas need to triple by 2030 and quadruple by 2050. Effective financial investment will require compiling precise biodiversity data, developing geospatial tools and metrics, creating models to assess the impact of economic activities, and establishing mechanisms to combine public support with private investment.

Investment in the restoration of ecosystems can deliver substantial economic, environmental, and social returns by minimising the risks and costs associated with biodiversity loss. **Rewilding Europe Capital** [38] (is one example of how to attract private investment by reducing loan risks and providing favorable conditions. This initiative supports businesses that enhance natural landscapes, for example by restoring wetlands in Finland and transforming Portuguese forests. By offering financial loans with reduced risks, it encourages investments that bolster local economies while promoting ecological resilience.

3.3.9 Land value capture

Land value capture (LVC) is a financial approach that enables municipalities to generate revenue by using the increase in land value resulting from public interventions, such as infrastructure

[37] https://www.eea.europa.eu/publications/financing-nature-as-a-solution

[38] https://rewildingeurope.com/rewilding-in-action/nature-based-economies/

development or regulatory changes. This mechanism ensures that the benefits generated by public investments are redistributed to the community, supporting additional sustainable development and climate adaptation projects.

LVC involves recovering a portion of the increase in land or property value resulting from **public actions** through tools such as improvement contributions, taxes, or agreements with private developers. These resources are then reinvested to fund further **urban initiatives**, contributing to mitigation, adaptation, and climate resilience projects.

This approach offers numerous **advantages** for municipalities. First, it enables the mobilisation of additional financial resources, reducing dependence on external funding. Second, it promotes **social equity** by ensuring that the benefits of public investments are redistributed to enhance local services and infrastructure. And third, it supports sustainable urban development by encouraging efficient land use.

Implementing LVC is an effective strategy for financing SECAPs, enabling municipalities to support renewable energy projects, fund climate adaptation measures, and promote energy efficiency. By using LVC strategically, financial and environmental challenges can be addressed, ensuring sufficient resources to achieve local climate objectives. However, the successful adoption of this approach requires a clear regulatory framework, strategic planning, and transparent governance.

Several cities have already demonstrated the potential of this approach in climate-relevant projects. In **London**, LVC has been applied since the late 2000s through planning obligations and the community infrastructure levy to finance major infrastructure investments, notably the Crossrail project (now the Elizabeth Line), which opened in 2022. The Greater London Authority raised approximately EUR 4.8 billion through LVC mechanisms. A portion of this funding has supported urban regeneration initiatives, including public green spaces, energy-efficient social housing, and sustainable mobility infrastructure in newly-connected districts (OECD 2022). In **Paris**, the Grand Paris Express project, launched in 2015 and expected to be completed by 2030, involves the construction of 200 km of new metro lines and 68 new stations. LVC mechanisms – such as zoning changes and developer contributions – have been used to help finance the overall project, estimated at over EUR 35 billion. These tools have also guided low-carbon urban development around new transit hubs, promoting densification, public transport use, and green public spaces (OECD 2022). In **Hamburg**, the HafenCity redevelopment project, initiated in 2000, is transforming 157 hectares of former port land into a climate-resilient urban district. The city, through its public development agency, drew on strategic land ownership and sales to capture the increase in land value resulting from public investments in infrastructure, flood protection, and transit. Revenues from these land transactions were reinvested in sustainable buildings, district heating networks, and elevated public spaces designed to withstand future climate risks. HafenCity is expected to host over 12 000 residents and 45 000 jobs, offering a model of how LVC mechanisms can support integrated urban planning and long-term climate adaptation (Given and Reisman 2019). These cases highlight how LVC can be a powerful instrument for financing urban transformation while aligning public investment, private development, and climate policy objectives.

3.3.10 Insurance mechanisms for climate adaptation

Insurance mechanisms are increasingly recognised as innovative financial tools to enhance climate adaptation. **Insurance companies** play a pivotal role by creating products that mitigate financial risks associated with climate-induced disasters. These mechanisms often operate within the

framework of mixed funding models, combining public and private contributions to enhance resilience and reduce vulnerabilities. Key insurance tools include:

- **parametric insurance**: provides predefined pay-outs when specific climate indicators (such as rainfall intensity, wind speed, or river levels) exceed agreed thresholds. This ensures fast access to funds for response and recovery, making it particularly valuable in urban areas prone to flash floods or storm surges. **Flood risk** is one of the most critical climate challenges for cities, as urban flooding – driven by intense rainfall, sea level rise, or overwhelmed drainage systems – can lead to extensive economic damage and human loss. Parametric flood insurance or risk-pooling arrangements can help municipalities improve their financial preparedness and reduce long-term recovery costs.
- **catastrophe bonds (cat bonds)**: transfer climate- and disaster-related risks to capital markets. Investors provide upfront capital and receive interest, but risk losing part of the principal if a specific catastrophe occurs. These instruments are increasingly used to finance large-scale resilience projects.
- **PPPs**: involve collaborations between insurance companies, governments, and international organisations to expand insurance coverage, promote climate awareness, and support infrastructure improvements, especially in high-risk or underinsured urban areas.

Insurance mechanisms offer multiple **benefits**, including:

- **risk transfer and cost reduction**: by transferring financial risks from governments and communities to private markets, insurance lowers the immediate burden of disaster recovery;
- **incentivising resilience**: policies tied to resilience-building measures encourage investments in sustainable infrastructure, reducing long-term climate vulnerabilities;
- **closing the protection gap**: expanding access to insurance in underinsured regions reduces economic losses and strengthens adaptive capacities.

Integrating insurance mechanisms into SECAP financing enables municipalities to secure additional resources for climate adaptation, while fostering collaborations that bridge public and private efforts.

Box 22. Parametric flood insurance in Paris (OECD 2014)

Location: Paris, France

Year: Pilot project launched in the late 2010s

Type of financial mechanism: Parametric insurance

Objective: To enable rapid post-flood response and improve financial preparedness for extreme weather events.

Programme description: In response to recurrent flood risks from the river Seine, the city of Paris piloted a parametric insurance scheme tailored to urban flooding. The mechanism provides automatic pay-outs to the city when pre-agreed hydrometric thresholds are exceeded, such as river water levels or rainfall intensity, enabling funds to be mobilised promptly for emergency interventions, infrastructure repair, and citizen assistance.

Results: (i) Accelerated disbursement of recovery funds following major flood events; (ii) improved integration of financial preparedness into urban risk management plans; (iii) increased resilience of public infrastructure and essential services through faster recovery timelines.

Challenges addressed: (i) Delays in post-disaster funding linked to traditional insurance models; (ii) difficulty in financing urban climate risks with uncertain frequency and intensity.

Lessons learned: (i) Parametric insurance can reduce the protection gap in cities by providing immediate, data-triggered pay-outs; (ii) embedding insurance within urban resilience strategies supports more effective emergency planning; (iii) local governments can benefit from tailored financial tools that align with specific climate hazards such as flooding.

Box 23. Flood Re – A public-private insurance scheme in the UK [39]

Location: United Kingdom

Year: Operational since 2016

Type of financial mechanism: Public-private reinsurance scheme

Objective: To expand flood insurance access and affordability for households in high-risk areas.

Programme description: Flood Re is a public-private partnership between the UK government and the insurance industry. It acts as a reinsurance pool, allowing insurers to pass on high-risk flood policies to the scheme, which absorbs part of the risk. This model enables affordable premiums for households located in flood-prone areas – many of which would otherwise be excluded from the insurance market.

Results: (i) Over 350 000 high-risk households gained access to affordable flood insurance; (ii) long-term risk-pooling created stability in the national insurance market; (iii) strengthened public-private cooperation in national climate risk management.

Challenges addressed (i) Exclusion of vulnerable households from flood insurance due to high premiums; (ii) ensuring actuarial and financial sustainability of the risk pool over time.

Lessons learned: (i) Public-private partnerships can make the insurance market more inclusive in climate-sensitive sectors; (ii) reinsurance mechanisms like Flood Re allow governments to share risk with the private sector while ensuring equity; (iii) transitional schemes must be accompanied by parallel investments in adaptation and flood protection to reduce long-term exposure.

Box 24. Subsidised drought insurance for farmers in Austria [40]

Location: Austria

Year: 2016

Type of financial mechanism: Subsidised public-private insurance system

Objective: To provide fair and rapid compensation for drought-related agricultural damage, reduce farmers' dependency on subsidies, and promote better financial planning through a public-private insurance model.

Programme description: Austria's subsidised drought insurance system combines indemnity-based and weather index-based products to cover agricultural losses due to droughts. This innovative approach shifts from *ad hoc* compensations to a structured system, offering farmers faster payouts and reducing economic and mental health pressures.

[39] https://www.floodre.co.uk/.

[40] https://climate-adapt.eea.europa.eu/en/metadata/case-studies/Subsidised-drought-insurance-for-farmers-in-Austria

Results: The insurance system provides more predictable budget management for the government and incentivises farmers to participate, with the state covering 55% of insurance premiums. It achieves high market penetration rates, with significant coverage in horticulture, fruit, and arable lands.

Challenges addressed: (i) Increasing frequency and severity of droughts due to climate change. (ii) farmers' economic vulnerability and mental health issues linked to unpredictable compensation; (iii) government's need for a sustainable, programmable budget for managing agricultural risks.

Lessons learned: (i) Combining indemnity and index-based insurance offers a balanced approach to risk management; (ii) public-private partnerships can effectively share the financial burden of climate risks; (iii) subsidising premiums encourages widespread adoption among farmers, enhancing resilience.

Additional Information: The system operates under the Austrian Hail Insurance Association and is supported by amendments to national disaster fund laws, illustrating a successful integration of climate adaptation into agricultural policy.

Box 25. Green roof insurance in the Netherlands [41]

Location: the Netherlands

Year: Ongoing, part of the PIISA (Piloting Innovative Insurance Solutions for Adaptation) project

Type of financial mechanism: Insurance incentives

Objective: To promote the widespread adoption of green roofs as a nature-based solution for climate adaptation, leveraging insurance incentives to align financial and environmental goals.

Programme description: The Dutch insurer Interpolis is encouraging policyholders to adopt green roofs as part of a broader climate adaptation strategy. This initiative leverages insurance incentives to encourage the installation of green roofs, which provide multiple benefits such as flood risk reduction, enhanced biodiversity, improved recreation spaces, and better insulation.

Results: The programme assesses societal benefits through surveys and cost-benefit analyses, demonstrating the value of green roofs in urban settings. It also explores effective insurance solutions and identifies public-private partnerships to support sustainable financing for green roof investments.

Challenges addressed: (i) Limited adoption of green roofs despite their known benefits; (ii) need for scalable financial models to promote nature-based urban solutions; (iii) integration of private sector financing in public environmental initiatives.

Lessons learned: (i) Insurance incentives can effectively encourage the adoption of green roofs by aligning financial and environmental goals; (ii) cross-sector collaboration through public-private partnerships can facilitate sustainable financing arrangements; (iii) the model's applicability is being explored in other regions, such as the Boreal and Mediterranean areas, highlighting the potential for broader implementation.

[41] https://piisa-project.eu/pilot1

4 Alternative instruments

Alternative financing models offer solutions for funding sustainable energy projects, enhancing community engagement and strengthening the link between investments and local benefits.

This chapter examines key **alternative and community-based financing instruments**, focusing on their potential to mobilise local resources, foster community participation, and accelerate the implementation of SECAPs. While these models can significantly expand financing sources, they require careful management and a well-structured engagement strategy to ensure their success and sustainability.

Table 3. List of alternative instruments: characteristics and description.

Scheme	Source of Funding	Contractual Typology	Description
Crowdfunding	Private	Equity/debt	Raising small amounts of capital from a large number of people, often through online platforms.
Energy cooperatives	Private/ citizen-based	Equity	Community-based organisations that pool funds to finance renewable energy projects and energy efficiency.
Pooled procurement	Mixed	Procurement	A group of organisations collaborate to procure goods or services collectively, often to save money.
Carbon finance	Private/mixed	Market-based	Monetisation of GHG emission reductions through carbon credits in voluntary or regulated markets (e.g. Paris Agreement Article 6). Provides additional funding for mitigation projects.

Source: JRC elaboration

4.1 Community-based funds

4.1.1 Crowdfunding and voluntary actions

Crowdfunding is a financing mechanism that **mobilises small contributions from a large group of people**, typically through online platforms. These platforms pool resources from diverse actors, often integrating energy cooperatives to enhance shared ownership and democratic decision-making. This approach empowers communities to actively participate in climate mitigation and adaptation projects [42]. The main **advantages** of crowdfunding include broadening access to financial resources, raising public awareness of climate issues, and fostering transparency. However, it faces **challenges** such as the need for robust regulations, secure data management, and trust-building regarding fund utilisation. Effective communication strategies and the selection of appropriate platforms are critical for success.

Notable crowdfunding initiatives include the **Engynious Schools Project** in the **UK**, which raised GBP 650 000 (approximately EUR 756 000) through the Abundance platform to install solar panels in 19 schools, enabling a 30% reduction in energy costs without upfront investment (Amin 2023).

[42] https://eu-mayors.ec.europa.eu/en/resources/funding_guide#guide_25

Box 26. Bettervest Crowdfunding Platform (Stelmakh and Novikova 2017)

Location: Germany (with international projects, including Hungary)

Year: Active since 2017

Type of financial Mechanism: Crowdfunding for energy efficiency and climate change mitigation projects

Objective: To mobilise community investments for financing sustainable energy projects, reducing energy costs, and promoting climate-friendly solutions.

Programme description: Bettervest is a German-based crowdfunding platform that has supported around 50 energy efficiency projects in Germany and other countries. Investments range from EUR 4 000 to EUR 600 000, with projects consistently meeting their funding goals.

One notable project involved a public school in Szeged, Hungary, with 1 150 students. The school upgraded its traditional lighting system to energy-efficient LED technology, achieving over 70% energy savings. Through Bettervest, EUR 46 400 was raised from 92 investors. The project was executed under a 10-year lease-to-own agreement with LED-LIGHT-Germany, which committed to repaying 100% of the capital within seven years while offering investors a 7% return. The project not only reduced the school's energy and maintenance costs but also demonstrated the scalability and economic benefits of crowdfunding for energy efficiency.

Results: (i) over 70% reduction in energy use for the school in Szeged; (ii) EUR 46 400 raised from community investors, showcasing the potential of crowdfunding to mobilise resources; (iii) 7% return on investment delivered within a structured financial framework.

Challenges addressed: (i) facilitating cross-border collaboration between investors, service providers, and beneficiaries; (ii) ensuring transparency and trust through structured agreements and reliable returns.

Lessons learned: (i) crowdfunding platforms like Bettervest effectively mobilise community capital for sustainable projects; (ii) transparent financial structures and attractive returns are crucial for maintaining investor confidence; (iii) combining crowdfunding with lease-to-own models makes it easier to scale up energy efficiency initiatives.

Voluntary actions provide a powerful boost to climate adaptation projects, fostering community involvement and enhancing resource availability during the implementation phase. Engaging local partners such as religious communities, sports clubs, schools, and grassroots initiatives provides several advantages. These partners provide financial support, time, and human resources, which are crucial for successful project execution. For example, local communities can participate in reforestation projects by planting trees, with local authorities supplying the seedlings or land. This collaborative approach can maximise the effectiveness of the project. The **Trees for Cities initiative, United Kingdom** [43] demonstrates the power of voluntary efforts, having organised fundraising and tree-planting events for over 30 years to improve the urban environment. With over 1.8 million trees planted, this initiative illustrates how voluntary actions can significantly bolster climate adaptation measures.

A notable voluntary action involving the community is the **privately funded climate-proof collective garden project in Vrijburcht, Amsterdam, the Netherlands.** Under this project, future

[43] https://www.treesforcities.org/

residents designed and organised financing for a climate-proof courtyard garden. The garden effectively manages stormwater, reduces heat stress, and enhances urban sustainability, showcasing how community-led initiatives can address climate challenges while fostering social cohesion [44].

4.1.2 Energy cooperatives

Energy cooperatives play a crucial role in empowering individuals who may lack confidence or resources to act independently. By joining a cooperative, members become part of a **community actively involved in energy-related actions** [45].

Energy cooperatives take various forms. Some **manage their own generation assets**, such as wind or solar farms. Others serve as **aggregators**, optimising the management of members' installations like rooftop PV systems. Additionally, some act as **financial intermediaries**, pooling members' resources to invest in large-scale renewable projects or support low-carbon renovations in public facilities.

These cooperatives offer significant **benefits**, not only for their members but also for local energy systems. They help with decarbonising electricity generation, enhance public understanding of energy markets, and foster active participation in the energy transition. Moreover, they can reduce energy bills or generate revenue for shareholders. Within the Covenant of Mayors framework, energy cooperatives play a vital role in supporting local plans to reduce greenhouse gas emissions and implement sustainable energy measures [46].

A notable example is **Som Energia**, a Spanish renewable energy cooperative that involved over 73 000 members in developing over 10 MW of renewable-energy capacity, generating 18.5 GWh annually – enough to power approximately 4 000 households. Som Energia successfully integrates crowdfunding, demonstrating how cooperatives can leverage diverse financial sources to expand community-owned renewable energy projects.

Crowdfunding platforms, when combined with energy cooperatives, further enhance resource-pooling through internet-based tools, amplifying community engagement and financial impact[47].

Box 27. Cooperative of Melpignano [48]

Location: Melpignano, Italy

Year: Ongoing

Type of financial mechanism: Energy cooperative for photovoltaic systems

Objective: To promote and implement a widespread network of photovoltaic systems on public and private buildings, empowering citizens as cooperative members and renewable energy producers.

[44] https://climate-adapt.eea.europa.eu/en/metadata/case-studies/vrijburcht-a-privately-funded-climate2013proof-collective-garden-in-amsterdam

[45] https://eu-mayors.ec.europa.eu/en/resources/funding_guide#guide_25

[46] http://citynvest.eu/content/citynvest-cooperative-model

[47] https://eu-mayors.ec.europa.eu/en/resources/funding_guide#guide_26

[48] http://www.coopcomunitamelpignano.it/

Programme description: The Melpignano Cooperative offers a pioneering model of energy engagement in Italy. Promoted by the municipality, the cooperative enables members of the public to become both members and owners of photovoltaic systems installed on their homes and businesses. By joining the cooperative, residents actively participate in developing and managing renewable energy infrastructure, fostering local sustainability and reducing dependence on traditional energy sources. This initiative not only generates clean energy but also strengthens community ties through shared ownership and decision-making.

Results: (i) Creation of a community-managed network of photovoltaic systems; (ii) increased renewable energy capacity in Melpignano, reducing reliance on non-renewable energy; (ii) active public participation in energy transition efforts, fostering a sense of ownership and responsibility.

Challenges addressed: (i) encouraging widespread participation in the cooperative model; (ii) ensuring technical and financial feasibility for large-scale deployment of photovoltaic systems.

Lessons learned: (i) Energy cooperatives can effectively integrate members of the public into the energy transition process; (ii) local government leadership is essential for initiating and supporting cooperative energy projects; (iii) shared ownership models foster transparency, trust, and long-term commitment to sustainability goals.

4.2 Collaborative mechanisms

Collaborative mechanisms bring together public authorities, private-sector actors, and communities to overcome financial and technical barriers in implementing sustainable energy projects. This section explores two key mechanisms: pooled procurement and carbon finance.

4.2.1 Pooled procurement

Pooled procurement involves public or private entities joining forces to purchase energy-efficient products or services, such as materials for building renovation, energy-efficient office equipment, or low-emission vehicles. By aggregating demand, this mechanism reduces costs through economies of scale, enhances market leverage, and simplifies procurement processes.

While its implementation requires coordination among participants and alignment of procurement goals, pooled procurement has proven effective in **achieving cost savings** and **promoting the adoption of sustainable technologies**. An example includes cooperative purchasing programmes in the EU that have facilitated large-scale adoption of energy-efficient lighting in municipal buildings, significantly reducing energy consumption.

Another example of pooled procurement for climate adaptation is the 'Soils of Brittany by Livelihoods' project in Brittany, France - a PPP that is helping 100 farmers to transition to regenerative agriculture to improve soil health, biodiversity, and CO_2 sequestration. With a EUR 6 million investment over 10 years, the project combines financial aid, technical support, and training. Key success factors include efficient funding through pooled private investments and the issuance of carbon credits to investors. The initiative involves regional authorities, agriculture stakeholders, and an investment fund, boosting the impact of adaptation measures through collaborative efforts (Commission for the Environment - Climate Change - Energy 2024).

4.2.2 Carbon finance

This mechanism enhances the financial viability of projects by **diversifying funding sources** and reducing reliance on grants or commercial loans. For instance, carbon finance has supported renewable energy projects and methane recovery initiatives globally. However, challenges include

risks associated with delivery performance and regulatory changes, which can affect credit purchase agreements.

Carbon finance refers to the generation of financial value from verified reductions in GHG emissions, typically through the issuance and sale of carbon credits. These credits can be traded in either regulated markets (as defined under Article 6 of the Paris Agreement) or **voluntary carbon markets**, where corporate and institutional buyers support climate mitigation projects.

By monetising emission reductions, carbon finance provides an additional revenue stream for projects that generate measurable climate benefits, such as renewable energy systems, energy efficiency retrofits, or nature-based solutions. It helps diversify funding sources and reduces dependence on grants or commercial loans, thereby enhancing financial viability.

For SECAP implementation, municipalities can engage in carbon finance by supporting or co-developing projects eligible for credit generation. For example, a city might issue credits for energy efficiency measures in municipal buildings or for district heating systems that reduce fossil fuel use.

The emerging framework under Article 6.2 and 6.4 of the Paris Agreement is expected to improve transparency and environmental integrity in international crediting. In parallel, the voluntary carbon market is expanding, allowing municipalities to collaborate with verified project developers or aggregators to access financing.

Despite its potential, carbon finance presents several challenges: (i) evolving regulatory standards and market volatility; (ii) complexity in monitoring and verifying long-term emission reductions; (iii) the risk of double counting or lack of co-benefits if not well designed.

When integrated carefully into climate action plans, carbon finance can mobilise private capital, incentivise high-impact mitigation, and increase the financial sustainability of local climate strategies.

5 Conclusions

Cities are at the forefront of the transition to a low-carbon future. However, significant barriers remain in accessing the financial resources needed to implement SECAPs. Key **challenges** include a persistent financing gap, limited administrative capacities, and difficulties in attracting private investments for high-risk projects. Addressing these challenges requires a **comprehensive and innovative approach** to financing, governance, and capacity-building.

5.1 Overcoming financial barriers

According to the World Cities Report 2024 (Labaeye and Stoffregen 2024), cities need substantial investments to achieve both mitigation and adaptation climate goals, but public funds alone are insufficient and it is hard to attract private capital. To address this funding gap, cities must adopt innovative approaches that mobilise both private and public resources.

One solution is to use **innovative and alternative financing instruments**, such as green bonds, blended finance, energy cooperatives, and crowdfunding platforms. These instruments allow cities to diversify their funding sources, access private capital, and reduce perceived risks, making climate projects more attractive to investors.

Green bonds are particularly effective for raising funds for renewable energy, energy efficiency, and sustainable infrastructure projects. These bonds enable the mobilisation of large-scale investments, attracting investors interested in funding projects that contribute to climate goals. Blended finance models, which combine public and private capital, offer a complementary solution by reducing risks for private investors through the use of public guarantees or grants, making projects more financially viable. The blended finance approach plays a crucial role in attracting funding for high-capital, long-term projects like climate resilience and green urban infrastructure.

One innovative financial tool - parametric insurance - is promising for climate adaptation. This insurance provides rapid financial relief based on predefined triggers like wind speed or rainfall, streamlining processing procedures for claims and reducing costs. This makes it particularly effective for managing climate risks in sectors such as agriculture and disaster relief.

Furthermore, crowdfunding and energy cooperatives are gaining popularity as mechanisms that promote community participation and reduce reliance on centralised funding. Platforms such as Bettervest and initiatives like the Melpignano Cooperative in Italy demonstrate how the public can be directly involved in the financial backing of climate projects, either through direct investments or as co-financiers of local energy solutions. This approach not only increases capital availability but also strengthens local ownership and engagement, which are essential for the long-term success and sustainability of projects.

To overcome **administrative capacity gaps** and facilitate access to funding, **OSSs** are proving to be essential tools. OSSs provide **technical assistance**, information on financing opportunities, and streamlined processes for project implementation. OSSs reduce **bureaucratic barriers** and help municipalities navigate the complexities of the financial landscape, ensuring effective deployment of resources. These platforms are particularly beneficial for smaller municipalities, which often lack the resources to manage complex projects on their own.

5.2 Key recommendations for climate-financing strategies

To address the financing challenges faced by municipalities, a combination of traditional and complementary (innovative and alternative) tools, capacity building, and enhanced governance is needed. Below are the key recommendations.

- **Foster public-private collaboration:** PPPs are a powerful model for leveraging private-sector expertise and funding. When green criteria are integrated into PPP frameworks, these partnerships can deliver significant climate benefits while driving local economic growth. Examples of successful PPPs include energy efficiency retrofits and renewable energy projects that align with SECAP objectives.
- **Scale up the use of innovative financial instruments:** municipalities should prioritise adopting tools like green bonds, climate resilience bonds, P4P models, and blended finance. These instruments provide the financial backbone for addressing both mitigation and adaptation challenges: (i) green bonds mobilise investments for sustainable projects; (ii) P4P models link payments to measurable energy savings, ensuring accountability; (iii) ESCOs finance energy efficiency projects without upfront costs, repaid through savings from reduced energy consumption**.**
- **Bridge the financing gap with inclusive solutions:** equity and inclusivity must be central to climate-financing strategies. Financial tools like green loans and energy-efficient mortgages ensure access for vulnerable groups, reducing energy poverty and promoting social equity. Revolving funds and crowdfunding platforms further expand the financial base for SECAPs while fostering community participation.
- **Enhance capacity building and knowledge sharing:** capacity-building is crucial for municipalities to successfully implement climate projects. Training programmes tailored to local needs, along with knowledge-sharing platforms, can empower municipalities to replicate successful models and avoid common pitfalls. OSSs play a pivotal role in providing municipalities with the tools and expertise needed to navigate complex financial landscapes.
- **Strengthen multi-level governance for systemic change:** collaboration across national, regional, and local levels ensures resource optimisation and policy alignment. Robust governance frameworks support cohesive and integrated approaches, enabling municipalities to drive systemic change and amplify the impact of climate initiatives.
- **Develop tailored financial strategies:** every city has unique challenges and opportunities. Local authorities should design financing strategies that reflect their specific climate goals and socioeconomic contexts. This approach ensures the selection of appropriate instruments that balance effectiveness and inclusivity.
- **Leverage co-benefits**: cities should integrate climate mitigation and adaptation into their financial strategies to maximise co-benefits. For instance, urban green spaces can reduce emissions and improve resilience. Projects with these co-benefits can unlock co-financing from non-climate sectors, attract diverse funding, and optimise resources. Ensuring projects are 'resilient by design' further appeals to stakeholders seeking comprehensive climate solutions.

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List of abbreviations and definitions

Abbreviations	Definitions
CBI	Climate Bonds Initiative
CDM	Clean Development Mechanism
CFI	Corporate financing institution
CHP	Combined heat and power
CoM	Covenant of Mayors
DFI	Development financial institution
EBRD	European Bank for Reconstruction and Development
EE	Energy efficiency
EEC	Energy efficiency credits
EEM	Energy-efficient mortgage
EIB	European Investment Bank
EIM	Energy improvement mortgage
ELENA	European local energy assistance
ENEF	Energy Efficiency Fund
EPC	Energy performance contracting
ERDF	European Regional Development Fund
ESCO	Energy services company
ESIF	European Structural and Investment Funds
ETS	Emissions trading system
EU	European Union

Abbreviations	Definitions
GHG	Greenhouse gas
HVAC	Heating Ventilation and Air Conditioning
LED	Light emitting diode
LVC	Land value capture
O&M	Operations & maintenance
OSS	One-stop shop
P4P	Pay-for-performance
PICO	Public internal performance commitments
PPP	Public-private partnership
PV	Photovoltaic
SDG	Sustainable Development Goal
SEAI	Sustainable Energy Authority of Ireland
SEAP	Sustainable energy action plan
SECAP	Sustainable energy and climate action plan
SMEs	Small and medium-sized enterprises
SPV	Special purpose vehicle
TIF	Tax increment financing
US	United States
VAT	Value added tax
VIPA	Lithuanian Public Investment Development Agency
VC	Venture capital

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Annexes

Annex 1. Financial mechanisms matrix

Matrix legend:
"●" direct and priority
"○" indirect and priority
"●" direct and less common
"○" indirect and less common
"□" intermediaries
"□" investors

Financial mechanisms:
"×" alternative
"×" innovative
"×" traditional

	Issuers										Beneficiaries												Sectors of use																Pillars		
	Governments		Banks		Business		Public and private utilities				Cities	Public and private utilities				Business		Individuals	Communities		Public and research		Energy			Buildings		Climate adaptation			Transport		Natural resources		Waste						
	National/Regional	Local	Multilateral (World Bank, EIB, EBRD)	Private (commercial banks, grenn banks)	Large corporations	Small and medium enterprises (SMEs)	Energy providers	Water companies	Waste management companies	Transport companies	Municipalities	Energy providers	Water companies	Waste management companies	Transport companies	Large corporations	Small and medium enterprises (SMEs)	Homeowners	Energy cooperatives	Community projects	Schools, hospitals	Universities and research centers	Renewable energy	Energy efficiency	Decarbonization	Energy retrofitting	Green buildings	Flood defences	Urban cooling systems	Resilience projects	Sustainable mobility	Electric public transportation	Water resource management	Biodiversity protection	Waste management	Circular economy	Mitigation	Adaptpation	Energy poverty
Grant programmes ×	●	●	●	○			○	○	○	○	●	○	○	○	○	●	●	●	○	○	●	●	●	●	●	●	●	○	○	○	○	○	○	○	○	●	○	●
Public grants ×	●	●	●	□			□	□	□	□	●	○	○	○	○	○	○	●	○	○	●	●	●	●	●	●	●	○	○	○	○	○	○	○	○	●	○	●
Tax incentives ×	●	●	○								○	○	○	○	○	●	●	●	○	○	●	●	●	●	●	●	●	○	○	○	●	●	○	○	○	○	●	○	●
Tax increment financing ×	○	●			□	□					●	○	○	○	○			○	○	○	●	●	○	○	●	●	●	○	○	○	●	●	○	○	○	○	●	○	○
Soft loans ×	●	●	●	□			□				●	○	○	○	○	●	●	○	○	○	●	●	●	●	●	●	●	○	○	○	○	○	○	○	○	●	○	●
Green loans ×	●	●	●	●/□			○	○	○	○	●	○	○	○	○	●	●	●	○	○	●	●	●	●	●	●	●	○	○	○	○	○	○	○	○	●	○	●
Revolving funds ×	●	●	●	○/□	□		○/□	○/□	○/□	○/□	●	○	○	○	○	●	●	○	○	○	●	●	●	●	●	●	●	○	○	○	○	○	○	○	○	●	○	○
Traditional bonds ×	●	●	●	□	●		●	●	●	●	●	○	○	○	○	○	○	○	○	○	●	●	●	●	●	●	●	○	○	○	○	○	○	○	○	●	○	○
Green bonds ×	●	●	●	○/□	●		●			●	●	○	○	○	○	○	○	○	○	○	●	●	●	●	●	●	●	○	○	○	○	○	○	○	○	●	○	○
Blue bonds ×	●	●	●	○/□	●			●			●	○	○	○	○	○	○	○	○	○	●	●	○					○		○	○	●	●	○	○	○	○	●	○
Climate bonds ×	●	●	●	○/□	●		●				●	○	○	○	○	○	○	○	○	○	●	●	●	●	●	●	●	○	○	○	○	○	●	○	○	○	●	○	○
Climate resilience bonds ×	●	●	●	○/□	●			●			●	○	○	○	○	○	○	○		○	●	●					○	●	○	○	○		●	●	○		○	●	○
Social bonds ×	●	●	●	○/□	●						●	○	○	○	○	○	○	●	●	●	●					○				○			○				○	●	●
Sustainability bonds ×	●	●	●	○/□	●		●	●		●	●	○	○	○	○	○	○	○	●	●	●	●	○	○		○				○		○		○		○	○	●
Mini-bonds ×	●	●	●	□	●	●	●	●	●	●	●	○	○	○	○	●	●	○	○	○	●		○	○		●	●			●	○			○		●	○	○	○
Carbon pricing (ETS, taxes) ×	●	●	□	□	□	□					●	○	○	○	○	○	○	○	○	○	●	●	●	●	●	●	○	○	○	○	●	●	○	○	○	○	●	○	○
Carbon finance ×	●	●	○	○/□	□	□	○	○	○	○	●	○	○	○	○	●	●	○	○	○	●	●	●	●	●	●	●				○	○			○	○	●		○
Energy efficient mortgages ×	○	○	○	●/□							○	○	○	○	○	○	○	●					○	○	○	●	●								○	●		

Source: JRC elaboration

Matrix explanations

The matrix analyses financial mechanisms, a category of financial instruments that directly provide funding, financial incentives, or economic support to projects related to sustainability, climate action, and energy transition. Unlike financial tools and models, which facilitate or structure financial flows, mechanisms actively channel resources to beneficiaries through direct financing, subsidies, tax incentives, and credit schemes.

For each financial mechanism included in the matrix, four key categories have been analysed.

1. **Issuers**: the entities responsible for originating or providing the financial mechanism. These include governments, multilateral banks, private banks, and, in some cases, public/private utilities or large corporations.
2. **Beneficiaries:** the recipients of financial support, categorised based on whether they directly access the mechanism or benefit from its indirect impacts. Beneficiaries include cities, public/private utilities, businesses, individuals, communities, and public entities or research institutions.
3. **Sectors of use:** the sectors in which the financial mechanism is applied, including energy, buildings, climate adaptation, transport, natural resources, and waste. Each mechanism has been evaluated based on whether it directly funds projects in these sectors or contributes to them indirectly.
4. **Pillars**: the broader objectives that the financial mechanism supports, including mitigation (GHG emissions reduction and low-impact technologies), adaptation (resilience to climate risks and climate-resilient infrastructure), and energy poverty (access to clean energy and cost reduction for vulnerable communities).

The classification system distinguishes the degree of directness and relevance for each financial mechanism:

- **direct and priority:** the financial mechanism explicitly targets and directly provides funding to a given entity, sector, or pillar as a primary objective.
- **indirect and priority:** the financial mechanism does not directly finance the entity, sector, or pillar but has a substantial impact through secondary channels, incentives, or market mechanisms.
- **direct and less common:** the financial mechanism can directly finance a given entity, sector, or pillar but does so less frequently or in specific circumstances.
- **indirect and less common:** the financial mechanism has only a marginal or occasional impact on a given entity, sector, or pillar.

Additionally, the matrix identifies:

- **intermediaries** – entities that do not directly issue or receive financial support but facilitate transactions;
- **investors** – entities that allocate capital to financial mechanisms with the expectation of financial returns.

Financial flows of mechanisms

Grant programmes

Grant programmes are primarily financed by governments and multilateral banks, as they are the main issuers of non-repayable funds to support EE, renewable energy, and climate adaptation initiatives. These entities provide direct and priority funding to municipalities, businesses, and public institutions. In some cases, private banks act as indirect facilitators, distributing concessional loans or co-financing initiatives linked to grant programmes, but their role is less common than public institutions. Additionally, public and private utilities may be indirectly involved when grants fund large-scale energy or infrastructure projects that benefit them, such as energy grid modernisation or water resource management programmes.

The main beneficiaries of grant programmes are: cities, direct and priority recipients for energy and infrastructure projects; public/private utilities, indirect but relevant beneficiaries when grants support large-scale projects; businesses, direct and priority beneficiaries, especially for industrial decarbonisation and energy efficiency initiatives; public institutions, direct and priority recipients of funding for building retrofitting and sustainability projects; communities, indirect and less common beneficiaries, benefiting from grants that support collective renewable energy solutions.

Public grants

Public grants are primarily financed by governments and multilateral banks, which provide non-repayable funding to support EE, climate adaptation, and broader public policy objectives. These funds are distributed directly to municipalities, public institutions, and individuals, while intermediaries, such as public energy agencies or managing authorities of EU funds, facilitate allocation and implementation. In some cases, private banks act as intermediaries by offering concessional loans or co-financing mechanisms tied to grant programmes. These intermediaries help facilitate access to funds but do not act as direct issuers of grants.

The key beneficiaries include: cities, as direct and priority recipients for energy retrofitting, sustainable infrastructure, and urban mobility projects; individuals, as direct and priority beneficiaries in programmes targeting energy poverty and residential energy efficiency; public/private utilities, as indirect and priority beneficiaries when grants support infrastructure modernisation; public institutions, as direct and priority recipients for energy-efficient building upgrades and sustainable technologies; businesses, as indirect and priority beneficiaries, particularly when grants stimulate private-sector investment; communities, as indirect and less common beneficiaries, often through grants supporting collective renewable energy solutions or community-led climate adaptation projects.

Tax incentives

Tax incentives are primarily implemented and financed by governments, which directly design and execute fiscal policies. These incentives, such as tax credits, exemptions, and accelerated depreciation, are administered to promote energy efficiency and sustainable practices. Multilateral banks provide indirect and less common support, such as technical assistance or co-financing programmes, to help governments establish and enhance fiscal frameworks.

Key beneficiaries include: businesses, as direct and priority recipients of accelerated depreciation or tax credits for investments in energy-saving technologies and equipment; individuals, as direct and priority beneficiaries of tax deductions or property tax relief for energy retrofitting and efficient

heating systems; public entities and research, as direct and priority recipients of tax incentives for energy-efficient retrofitting or adoption of sustainable technologies; cities, as indirect and priority beneficiaries through fiscal policies that promote sustainable urban infrastructure, such as electric public transport or green buildings; public/private utilities, as indirect recipients when incentives indirectly boost demand for infrastructure upgrades; communities, as indirect and less common beneficiaries, especially for incentives supporting collective energy solutions.

Tax increment financing

Tax increment financing (TIF) is initiated and implemented by local authorities, which act as the primary issuers. The mechanism relies on the anticipated future increases in property tax revenues generated by economic growth or infrastructure improvements in a designated area. While regional or national governments may indirectly support TIF by providing enabling legislation or technical assistance, the responsibility for issuing and managing TIFs lies primarily with local authorities. Private-sector actors, such as developers and property owners, play a critical role as investors, contributing capital to the redevelopment of designated areas. Their investments in infrastructure upgrades or property improvements catalyse the economic growth needed to generate future tax increments.

Key beneficiaries and financial actors: cities, as direct and priority beneficiaries, as TIF provides a mechanism for funding urban development and infrastructure upgrades; public entities and research, as direct and priority beneficiaries when TIF is used to fund energy retrofitting or efficiency improvements in public buildings; businesses, as investors who contribute capital to enhance property values and catalyse economic growth in the designated area; public/private utilities, as indirect beneficiaries when TIF is used to improve infrastructure, such as renewable energy systems or public transportation; communities, as indirect and less common beneficiaries, benefiting from local infrastructure improvements supported by TIF; individuals, as indirect and less common beneficiaries, gaining from improved infrastructure, higher property values, and reduced energy costs.

Soft loans

Soft loans are primarily issued by governments and multilateral financial institutions, which provide funding to reduce borrowing costs for EE and sustainability projects. These issuers ensure favourable financing conditions, such as below-market interest rates and extended repayment periods, to overcome financing barriers for EE projects. Private Banks act as intermediaries in the distribution of soft loans, leveraging funds provided by public entities or international institutions. They play a critical role in channelling funds to project developers, businesses, and municipalities. Businesses and public/private utilities are primarily beneficiaries, not issuers, but utilities may occasionally serve as co-financiers or intermediaries in managing targeted loan schemes, especially for infrastructure-related projects.

Key beneficiaries and financial actors: cities, as direct and priority beneficiaries, as soft loans are often used for large-scale energy retrofitting or infrastructure projects; businesses, as direct and priority beneficiaries for EPC and other energy efficiency investments; public/private utilities, typically as indirect and priority beneficiaries, but occasionally as intermediaries or co-financers for specific programmes; public entities, as direct and priority recipients of soft loans for sustainable retrofits and energy-saving measures; individuals, as indirect and priority beneficiaries for residential retrofitting projects supported by soft loans.

Green loans

Green loans are hybrid financial instruments that combine public funding with private-sector involvement. Public entities provide subsidies, guarantees, or concessional funds to de-risk investments, making green loans attractive to private investors. Private banks act as the primary intermediaries, distributing green loans to beneficiaries. Multilateral banks often play an indirect role by co-financing or supporting programmes through technical assistance.

Key beneficiaries include: cities, as direct and priority beneficiaries for infrastructure and energy efficiency projects; businesses, as direct and priority recipients for renewable energy installations or green technology investments; public entities, as direct beneficiaries for retrofitting or installing renewable energy systems; individuals, as direct and priority beneficiaries, especially low-income households targeted by programmes addressing energy poverty; public/private utilities, as indirect beneficiaries when green loans finance infrastructure upgrades; communities, as indirect beneficiaries, particularly in community-driven renewable energy projects.

Revolving funds

Revolving funds are primarily established by governments and can be supported by multilateral banks or private contributions. Initial capitalisation often comes from grants, subsidies, or loans, which are reinvested into the fund to create a self-sustaining financing mechanism. Private banks may act as intermediaries in managing revolving funds or disbursing financing for eligible projects. External donors and financiers, including institutional investors, may provide additional resources to expand the funds' scope.

Key beneficiaries include: cities, as direct and priority beneficiaries for energy efficiency and infrastructure projects, such as modernising municipal buildings and street lighting; businesses, as direct and priority beneficiaries for EPCs and retrofitting projects, occasionally acting as intermediaries for managing supplier-level initiatives; public/private utilities, as indirect beneficiaries for infrastructure upgrades, occasionally intermediaries in managing specific projects funded by revolving funds; public entities, as direct and priority recipients for sustainable retrofitting and infrastructure improvements; communities, as indirect beneficiaries, particularly for collective energy efficiency projects.

Traditional bonds

Traditional bonds are primarily issued by governments and multilateral banks to finance large-scale investment projects in energy efficiency, sustainable infrastructure, and climate adaptation. Occasionally, businesses and public/private utilities may issue bonds for sustainability-related initiatives. Private banks do not issue bonds but act as major investors, purchasing them to provide large-scale capital.

Key beneficiaries include: cities and regions, as direct and priority beneficiaries, using bonds to finance public infrastructure and climate projects; public/private utilities, as indirect and common beneficiaries, particularly in energy and transport infrastructure upgrades; businesses, as indirect and priority beneficiaries, benefiting from bond-financed projects, occasionally issuing bonds themselves; individuals, as indirect and less common beneficiaries, gaining from municipal infrastructure investments; communities, as indirect and less common beneficiaries, sometimes included in municipal bond projects supporting local renewable energy; public entities and research, as direct and priority beneficiaries, receiving funding for energy-efficient building retrofitting and research initiatives.

Green bonds

Green bonds are primarily issued by governments and multilateral banks to finance projects dealing with sustainability, climate adaptation, and energy transition. Public/private utilities and large corporations occasionally issue green bonds to finance energy efficiency, transport electrification, and decarbonisation projects. Private banks do not issue green bonds but act as major investors, purchasing them to provide capital for sustainability projects.

Key beneficiaries include: cities and regions, as direct and priority beneficiaries, using green bonds to finance sustainable urban infrastructure and climate adaptation; public/private utilities, as indirect and common beneficiaries, benefiting from funding for energy grids, public transport electrification, and water infrastructure; businesses, as indirect and priority beneficiaries, particularly when involved in green-bond-financed projects or issuing bonds for corporate sustainability; individuals, as indirect and less common beneficiaries, benefiting from green bonds funding energy-efficient urban development; communities, as indirect and less common beneficiaries, sometimes included in projects supporting local renewable energy and energy cooperatives; public entities and research, as direct and priority beneficiaries, receiving funding for energy-efficient building retrofitting and sustainability research projects.

Blue bonds

Blue bonds are primarily issued by governments and multilateral banks to finance projects focused on water resource management, coastal protection, and climate adaptation. Public/private utilities and large corporations occasionally issue blue bonds to fund sustainable water infrastructure and marine ecosystem protection. Private banks do not issue blue bonds but act as major investors, purchasing them to provide capital for water-related sustainability projects.

Key beneficiaries include: cities and regions, as direct and priority beneficiaries, using blue bonds to finance water resilience infrastructure and urban flood protection; public/private utilities, as indirect and common beneficiaries, benefiting from funding for sustainable water management, flood mitigation, and coastal protection; businesses, as indirect and priority beneficiaries, particularly when involved in blue bond-financed infrastructure projects or issuing bonds for water sustainability; individuals, as indirect and less common beneficiaries, benefiting from blue bonds funding urban flood mitigation and resilient water infrastructure; communities, as indirect and less common beneficiaries, sometimes included in projects supporting local water management and marine conservation; public entities and research, as direct and priority beneficiaries, receiving funding for water-efficient infrastructure and environmental research.

Climate bonds

Climate bonds are primarily issued by governments and multilateral banks to finance projects that reduce GHG emissions and accelerate the transition to a low-carbon economy. Public/private utilities and large corporations may also issue climate bonds to fund infrastructure decarbonisation and energy transition initiatives. Private Banks do not issue climate bonds but act as key investors, purchasing them to provide capital for large-scale climate projects.

Key beneficiaries include: cities and regions, using climate bonds to finance urban decarbonisation and sustainable transport; public/private utilities, benefiting from funding for renewable energy, smart grids, and public transport electrification; businesses, particularly when involved in climate bond-financed projects or issuing bonds for corporate decarbonisation; individuals, benefiting from climate bonds funding urban energy efficiency and clean mobility projects; communities, sometimes included

in projects supporting local renewable energy and climate adaptation efforts; public entities and research, receiving funding for energy-efficient public buildings and sustainability research projects.

Climate resilience bonds

Climate resilience bonds are primarily issued by governments and multilateral banks to finance projects that enhance resilience to climate risks. Public/private utilities and large corporations may also issue climate resilience bonds to fund infrastructure adaptation and water management initiatives. Private Banks do not issue climate resilience bonds but act as key investors, purchasing them to provide capital for large-scale climate adaptation projects.

Key beneficiaries include: cities and regions, using climate resilience bonds to finance flood defences, resilient infrastructure, and climate adaptation strategies; public/private utilities, benefiting from funding for water resource management, coastal protection, and infrastructure resilience; businesses, particularly when involved in climate resilience bond-financed projects or issuing bonds for corporate adaptation measures; individuals, benefiting from resilience-focused urban development and infrastructure projects; communities, sometimes included in projects supporting local climate adaptation efforts; public entities and research, receiving funding for climate-resilient public buildings and adaptation research projects.

Social bonds

Social bonds are primarily issued by governments and multilateral banks to finance projects that address social challenges and improve access to essential services. Public/private utilities and large corporations may also issue social bonds to fund initiatives related to social inclusion, affordable housing, and public welfare. Private banks do not issue social bonds but act as key investors, purchasing them to provide capital for large-scale social impact projects.

Key beneficiaries include: cities and regions, using social bonds to finance public services, social infrastructure, and inclusive urban development; public/private utilities, benefiting from funding for water accessibility, energy affordability, and transport inclusivity; businesses, particularly when involved in social bond-financed projects or issuing bonds for corporate social responsibility initiatives; individuals, benefiting from social programmes focused on affordable housing, employment, and healthcare access; communities, sometimes included in projects supporting local development, social equity, and education; public entities and research, receiving funding for hospitals, schools, and research on social sustainability.

Sustainability bonds

Sustainability bonds are primarily issued by governments and multilateral banks to finance projects that generate both environmental and social benefits. Public/private utilities and large corporations may also issue sustainability bonds to fund initiatives that integrate green and social objectives, such as renewable energy projects with social infrastructure or affordable housing with energy efficiency measures. Private banks do not issue sustainability bonds but act as key investors, purchasing them to provide capital for projects that align with sustainability and social impact goals.

Key beneficiaries include: cities and regions, using sustainability bonds to finance integrated urban development with environmental and social benefits; public/private utilities, benefiting from funding for renewable energy, water resource management, and infrastructure resilience; businesses, particularly when involved in sustainability bond-financed projects or issuing bonds for corporate environmental and social initiatives; individuals, benefiting from projects that improve access to

energy-efficient housing, public services, and clean mobility; communities, sometimes included in projects supporting local renewable energy, social equity, and education; public entities and research, receiving funding for sustainable public buildings, healthcare, and education initiatives.

Mini-bonds

Mini-bonds are primarily issued by governments, SMEs, and multilateral banks to raise capital for local infrastructure and business development projects. Public/private utilities and large corporations may also issue mini-bonds to finance sustainability-focused initiatives such as renewable energy, waste management, and energy efficiency improvements. Private banks do not issue mini-bonds but act as key investors, purchasing them to provide capital for small-scale sustainable projects.

Key beneficiaries include: cities and regions, using mini-bonds to finance urban regeneration, public infrastructure, and local sustainability initiatives; public/private utilities, benefiting from funding for energy efficiency, waste management, and water infrastructure; businesses, particularly SMEs, using mini-bonds as an alternative financing tool for sustainable investments; individuals, benefiting from local projects that improve access to essential services and energy-efficient housing; communities, sometimes included in projects supporting local sustainability efforts and economic resilience; public entities and research, receiving funding for public buildings, social infrastructure, and innovation in sustainability.

Carbon pricing

Carbon-pricing mechanisms, including ETSs and carbon taxes, are primarily issued by governments at national, regional, and local levels. Multilateral banks provide indirect support by financing technical assistance and policy development. Private banks and carbon market platforms act as intermediaries, facilitating the trading of emission allowances and supporting financial transactions in carbon markets. Large corporations and SMEs are classified as investors, as they participate in ETS markets, purchasing allowances or paying carbon taxes to comply with emission reduction targets.

Key beneficiaries include cities, businesses, public/private utilities, public entities and research. Carbon pricing generates revenues that can be reinvested in renewable energy, energy efficiency, decarbonisation, energy retrofitting, green buildings, sustainable mobility, electric public transportation, flood defences, urban cooling systems, and resilience projects. Its primary impact is on greenhouse gas emissions reduction and low-impact technologies, with indirect effects on climate resilience and adaptation through reinvestment strategies.

Carbon finance

Carbon finance mechanisms, including carbon credit markets and offset schemes, are primarily issued by governments at national, regional, and local levels. Multilateral banks provide indirect support by financing technical assistance and funding carbon credit programmes. Private banks and carbon market platforms act as intermediaries, facilitating transactions and investments in carbon credit markets. Large corporations and SMEs are classified as investors, purchasing carbon credits to offset emissions and comply with regulatory frameworks.

Key beneficiaries include cities, businesses, public/private utilities, public entities and research. Carbon finance supports projects in renewable energy, energy efficiency, decarbonisation, energy retrofitting, sustainable mobility, electric public transportation, biodiversity protection, waste management, circular economy.

Energy-efficient mortgages

Energy-efficient mortgages are primarily issued by private banks, which provide loans with favourable terms to finance the purchase or renovation of energy-efficient homes. Governments at national, regional, and local levels act as indirect issuers by offering incentives and guarantee schemes to support these mortgages. Multilateral banks provide indirect support by funding national energy mortgage programmes and technical assistance.

Key beneficiaries include homeowners, who access financing for purchasing or upgrading energy-efficient properties; businesses, particularly construction and renovation companies benefiting from increased demand for energy-efficient buildings; public/private utilities, indirectly benefiting from reduced energy demand due to efficiency improvements; cities, integrating energy-efficient mortgage programmes into broader urban sustainability initiatives; public entities and research, involved in setting efficiency standards and certification programmes.

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